STANDARD PRACTICAL PLUMBING.

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STANDARD

PRACTICAL PLUMBING

BEING

A COMPLETE ENCYCLOPÆDIA FOR PRACTICAL PLUMBERS AND GUIDE FOR ARCHITECTS, BUILDERS GAS FITTERS, HOT WATER FITTERS, IRONMONGERS, LEAD BURNERS, SANITARY ENGINEERS, ZINC WORKERS,

RECOMMENDED BY THE WORSHIPFUL COMPANY OF PLUMBERS AS A TEXT BOOK FOR REGISTERED PLUMBERS, EXAMINATIONS, &c.

IN TWO VOLUMES

Illustrated with over 2,000 Engravings.

BY

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P. J. DAVIES,

Sole Promoter of the Registration Scheme for Plumbers, and also of the Plumbers' Congress, held in London, 1884; *Member of the Amalgamated Society of Plumbers, London; Member of the Phonetic Shorthand Society, Bath; Member of the Society of Arts; Gold Medallist for Plumbing in the International Exhibition,* 1862; *Prize Medallist for Lead Burning at the Agricultural Hall, Islington,* 1871; *Inventor and Patentee of the Celebrated London Closet Valve, the Celebrated Submerged Waste-not Suction Closet Valve, the Frugal Suction Valve, &c., &c.; also Author of the long series of Articles, "Practical Notes on Plumbing" and "Lead Light Glazing," "Hydraulic Ram Work," "Pump Work," "Hot Water Work," "Town and other Water Supply," "Roof Work," &c., which appeared in the "Building News," "English Mechanic," and "Scientific American;" also Author of Articles on "Plumbers' Work and Lead Working," in the "House Decorator and School of Design;" also Author of the Articles on "Practical Plumbing," "House Drainage," "Plumbers' Work," "Lead Burning," "Geometry for Plumbers," &c., &c., which have from time to time appeared in the "Plumber and Decorator."*

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ADVICE TO PLUMBERS (see Page 53).

Experience teaches me that the more a man knows the more he can learn, and the more willing he is to impart that knowledge the more he improves himself thereby becoming of greater value to himself, to society, and to the world at large.—P. J. Davies.

Dedicated

TO THE

PLUMBING CRAFT.

I, AS a practical working plumber, and well-known member of the Plumbing Craft, respectfully dedicate this work to Practical Plumbers, and hope it may assist in facilitating the teaching of TECHNICAL PLUMBING, and in every way promote the spread of our ancient trade in this our nineteenth century.

Your very obedient servant,

PHILIP JOHN DAVIES,

Certificated and Registered Teacher of Plumbing, Gresham College, London, 1882.

78, Earl's Court Road,
Kensington, London,
3rd day of March, 1885.

PREFACE.

MY intention in this work is to supply a great want, namely, a set of thoroughly practical instructions and book of reference suitable for the workman that he may safely use as his guide in any job, however intricate, in the art of plumbing.

Part of the subject matter of this work has already appeared in journalistic form, to wit: in *The Building News*, *The Scientific American*, *The English Mechanic*, *The Plumber and Decorator*, *The House Decorator and School of Design*, &c., &c., and has already met with the hearty approval of those competent to judge; and as my rights are reserved, and having been pressed by my numerous readers to reproduce it in book form, I have rewritten it, and added a large amount of new matter and engravings suitable for an Encyclopædia of Plumbing.

I have also given a series of Examination Questions suitable for Schools of Plumbing, and which every good Practical Plumber should be able to answer with ease.

I have also given copies of the Waterworks Acts of Parliament and Acts of Parliament relating to drainage, etc.

I have also given a few Specifications of Plumbing, suitable for Architects and Builders. The drainage portion of this work is thoroughly exhaustive, not only suitable for houses but for stabling, cow sheds, &c.

I have treated upon every subject connected with the plumbing trade, and have embodied in this work all the theoretical and scientific knowledge necessary for the elucidation of the subjects treated of, and have at the same time carefully excluded all unnecessary learned dissertation, as I think that much *theory*, although extremely interesting to some, would be somewhat irksome to the *practical* mechanic, and would in a measure defeat my object. Therefore, I have made *simplicity of language and clearness of elucidation my particular aim*; and, if my fellow-workmen appreciate my efforts, and find the result of my long experience useful to them, I shall be amply repaid for my labour. For those for whom this work is too large or expensive I have been asked to produce a small pocket-book, which I am now engaged upon, and which will be useful to the apprentice, more especially as the price will be very low and at the command of all.

APOLOGY.

I HAVE written all my works upon this trade before publishing one book, and I feel it almost necessary to apologize to my readers for the apparently extreme length to which my writings have run; but, as in our trade there is such variety of different methods and modes of doing plumbing in different localities, it is absolutely necessary that these manifold inventions, and the different methods of work, should be known by the modern plumber; and unless the minutiæ of the various operations be thoroughly entered into, suitable for all these different villages, towns, and countries, the plumber, when he is transferred from one shop to another, feels himself to a very great degree out of place, which none know better than our best workmen. Therefore, I beg to be excused for putting the various styles before you, so that you may judge which is the best. In fact, my particularizing so minutely the various styles in use, I consider, constitutes the chief value of my works; more especially as the modern plumber is supposed to know, not only the most suitable articles for his particular class of work, but *where the same may be obtained.* This fact is more than proved by the multitude of letters which I have answered through the different trade journals, more especially through the pages of the *Building News*, *English Mechanic*, *Plumber*, &c., to say nothing of scores weekly by post, and which I will always continue to answer.

INTRODUCTION

PLUMBING *in all its branches* as practised in England at the present day demands a very extensive range of knowledge, for without an intimate and accurate knowledge of the rules to be hereafter observed, which rules are the result of much careful observation, experiment, and research, it will be impossible to practice the art in an efficient manner. We are all sensible of the fact, so far as sanitary plumbing is concerned, which I consider only a very minor part to learn, that in large towns, country mansions, farms, &c., health and life are in a measure dependent upon such work; and, in order that we shall be able to judge rightly, it is all-important that we should understand both the theory and the practical part of the work, together with the old and new styles of doing the same. I may here mention that I have worked hard at the *practical* part of plumbing work, including such as is done in chemical works, distilleries, breweries, mansions, farms, &c. Not only have I worked with my hands, but I have made the theory my particular study for over a quarter of a century, and I have spent many thousands of pounds, which I have derived from my patents, &c., in teaching myself not only the practical part, but the chemical and theoretical work, together with the best methods of doing the same. I may add that in order to obtain this knowledge, I have visited and joined many trade and other societies, the former of which I have learnt a great deal from, and I have worked in journeymanlike manner, *sub-rosa*, in the employ of the best full paid plumbing establishments in England, Scotland, and America; and, in order to well ground myself in the historical part of the work, I spent, as may seen by the visitors' books, the greater part of the years 1876, '77, and '78 in the Great Seal Patent Office, the British Museum, and our South Kensington Museum libraries, &c., gleanings wherefrom I shall place before you, in order that you may determine for yourselves whether we are advancing or retrograding in our work.

Now, my experience teaches me that, although the art of lead working may be acquired in the ordinary term of an apprenticeship, the plumber's work, as now practised in England, takes double this time, inasmuch as the plumber, as the age requires, must not only be a skilled lead worker, but he must also be well versed in water-closet work, the theory and practice of pump work, including the fixing and repairing of hydraulic rams; also bath work, which latter requires a knowledge of the principles regulating the circulation of hot and cold water. He must also have a knowledge of zinc working and gas fitting, and be able to carry out efficient methods of ventilation; and should have a thorough knowledge of pneumatics and hydraulics, especially of that branch of the science which treats of the pump and the flow of water through pipes and valves. A knowledge of plane geometry (I have written a work on this science expressly for plumbers) is, moreover, indispensable to the plumber; and, finally, I would have every plumber a proficient lead burner, which, I am sorry to say, not one out of five hundred is.

After what I have said, no doubt my readers will feel a little alarmed, as it cannot be expected that every journeyman plumber would be able to spend thousands of pounds in learning his trade; but I write this only to show what the present age, through the sanitation bubble, requires. We have the quasi-sanitary engineers to please, and by the latter we are sometimes examined at our examinations; and, unless we can talk to them in their own language, although well up in practice, we are counted by them as a sort of outsiders. In fact, they make nothing to do of crediting us as being an arbitrary class of men, and they expect that we must be not only plumbers, but, under their present system of working their examinations, &c., we are required to be thorough scientific individuals—in fact, nothing more nor less than engineers, chemists, metallurgists, and finished philosophers. But we will away with all connections with the quasi-sanitary engineers, and follow the works suitable for the young plumber.

I shall now introduce to your notice a syllabus of work for a class which I was appointed to teach at the Polytechnic Institution, 309, Regent Street, London, in the year 1882, but which, of course, you would not be required to master at one examination (I may say that Mr. Wright Clark is now teacher at this School of Plumbing):—

SYLLABUS.

1. The properties and qualities of lead, zinc, and tin; of iron, white and red lead, lead oxides, cements, etc.; the special uses to which any of these various substances are applied in plumbing.

2. The action upon lead, zinc, and tin of air, of different qualities of water, of the commoner acids, of sewage gases, etc.

3. Solders and soldering; composition and use of the various solders; fluxes and soldering fluids; theory and practice of soldering; soldering bits; blowpipes; brazing; autogenous soldering.

4. The tools used in plumbers' work—their forms, uses, etc.

5. Manufacture of the metals into the various forms in which they are used in plumbing; cast sheet lead; milled sheet lead; rolled zinc; galvanized iron; casting lead tubes: coating tubes internally.

6. Gas-fittings; measurement of pressure of gas in a main or pipe; forms of burners; gas-meters, wet and dry; gas-valves.

7. Sanitary arrangements in dwelling-houses (town and country) and other buildings; common defects; methods of testing drains, soil pipes, etc.; principal points to be attended to in (1) fitting new houses, (2) remedying existing defects.

8. Water-closets and their fittings; service boxes; waste-water preventers; earth-closets; ash-closets, etc.; baths, sinks, urinals.

9. Water-supply for houses; dangers arising from insufficient or impure supply; house cisterns—their construction, position, management, and care; filters; water-meters; arrangements for collecting and storing rain-water; connection between disease and water; dangers of water from surface wells; dangers from connection between cesspools and water supply.

10. Roofing; rain-drainage of houses; external plumbers' work.

11. Varieties of traps, D-traps, S-traps, bell-traps, etc.—their use and abuse; soil pipes; connection with the drain; connection of drain with sewer; ventilation of soil-pipes and drains; sizes of pipes; amount of fall required; objections to brick drains; proper materials and constructions for drains; joints for drain pipes, and methods of laying the same.

From the above it is plain that you must know all about zinc, iron and cement, the action of air, the different qualities of water, acids, sewer gas, &c., on lead, zinc, and tin, and brazing; then you are expected to know all about rolled zinc, and galvanized iron, &c., gasfittings, gas meters, &c., filters and water meters, all of which we are supposed to be familiarly acquainted with.

Before I conclude this preamble, I wish to draw the young plumber's attention to that which I consider to be only a snare, and which is to be found in the syllabusses, and in most of the text books of mechanical writers, and that is the present method of gaining the certificates by way of book-learnt answers. I may add that by far the most of our best plumbers lack in description,—that is to say, although they may be thoroughly practical men, they cannot elucidate their ideas upon paper, and nearly all those book-plumbers that can, I am sorry to say, are men who can only do a certain class of work; and as a rule these men have a general smattering of sanitation, and owing to this mania they find no difficulty in making themselves heard, to the very great detriment of the real plumber. Therefore, although I write this and my other works upon the trade, be it distinctly understood that upon no account should you consider that you will be a bit the better for reading them, so far as regards the *art*, without thoroughly practising every line there laid down; you will be utterly disappointed, and by practical men always snubbed, although you may from the study of these works be easily enabled to gain medals, mentions, and certificates, which to my mind—although I hold many of such—would be entirely worthless without the practical part, as there is more value in the little finger of the practical man than in the whole body of the theorist.

I have many letters of recommendation from nearly every trade journal both in England and abroad, from a few of which I have great pleasure here to give a few extracts, and I am pleased to say that many of my readers—unsolicited—have been kind enough to indite in the following terms:— In a letter dated September 12, 1881, the celebrated sanitarian, Mr. Geo. Jennings, says: "I have read with interest your able articles in the *Building News*, they are to young plumbers grains of gold, and very useful for references"; and in a subsequent letter he says: "No one but a thorough practical plumber can judge the merits of your very valuable writings." In a letter from Dr. Robert Ellis, of the Raven Spring, Mitcham, dated December 12, 1881, he says: "Your papers in the *Englisn Mechanic*, the very best scientific paper in the world, clearly show me that you are one of the few men whose knowledge and skill go hand in hand."

These are only two letters out of many hundreds which I have received from the leading plumbers and sanitarians of the day, such as Mr. Buchan, author of "Plumbing." This gentleman in a letter says: "I cannot understand how you get through so much work; you are made of steel." Mr. Barnes Austin, another great author on sanitary matters, also follows up in the same strain. The following are a few hastily picked from the beforementioned trade journals: From the *Building News*—

"Mr. Davies really deserves great praise for the able manner in which he gives us the articles entitled 'Practical Notes on Plumbing, Plumbers' Work, and Lead Working,' which are indeed interesting." Mr. J. Pullen, when speaking at the Society of Arts' Rooms upon my writings, &c., said: "To quote the best authority on plumbing, scientific and practical, Mr. P. J. Davies says," &c., &c. The *Building News*, in a leader on the battle of the traps, says: "Mr. Davies has by his graphical method of striking out the form of traps he recommended endeavoured to solve this problem, and we refer our readers to his demonstration"; then it goes on to say, "Mr. Davies' improvements are steps in the right direction."

Mr. Daniel Emptage, Sanitary Engineer, Dane Hill Sanitary Works, Margate, in a letter to the *Building News* says: "Mr. P. J. Davies has been doing good service for some time past by publishing in your columns his practical notes on plumbing, and I, for one, thank him very much for them."

J. W. Holland in writing a letter on traps &c., to the *Building News*, 4th November, 1881, says "There is no doubt great good will proceed from the opinions and experience of the several correspondents who have taken part in the controversy, especially from the able and practical articles written by Mr. Davies."

In the *Building News* of November 18, 1881, on page 675, Fairplay writes as follows: "Many thanks for Mr. Davies' splendid articles on plumbing: they make one fancy being at work when I read them."

Mr. J. Pullen, Junr., the well known plumber and lead burner, says in the *Building News* of November 18, 1881: "I only know Mr. Davies to be a thorough plumber, whose only connection with us is the unity of ideas, the result of training in sanitary matters from our youth upwards."

Mr. Hellyer, author of the "*Plumber and Sanitary Houses*," in one of his lectures, says (which I quote from the *Building News*): "He was glad Mr. Davies had found out the way to improve the D Trap."

Mr. J. Willis in a letter to the *Building News*, January 20, 1882 says: "Your articles on plumbing are exceedingly good." "Mr. Davies' writings are too plain to be misunderstood."

In an article in the *Building News*, March 3, 1882, on the competition tests held at South Kensington, it says: "Mr. Davies practically exhibited to the competitors some capital specimens of lead burning, and if other experienced plumbers were to illustrate different branches of handiwork, these examinations would be the means of conferring great benefit upon the younger members of the craft."

In a leader headed "The National Health Society," in the *Plumber and Decorator* for April 1, 1882, page 76, it says: "Some lead burning was done by Mr. P. J. Davies, who, by the way, has already made himself famous by his inventions and various workings in the different branches of the plumbing trade." "Mr. Davies performed some excellent specimens of flat and side or horizontal burning," it also says: "and in the production of some first-rate specimens of upright lead burning, having the appearance of split peas carefully laid in order," also, "We could well do with a few more members in the plumbing trade, who would take as much trouble to instruct brother tradesmen as Mr. Davies does."

Mr. Buchan, a gentleman of no small standing in our trade, in writing to the *Plumber and Decorator*, says: "Sir, I have read with much interest the able articles by Mr. P. J. Davies," and in Mr. Buchan's book on Plumbing (see the fourth edition, page 289), he says: "Mr. P. J. Davies has both experimented and written much in connection with plumbing."

A letter from T. Moore, a forty-year plumber, of Raymond Buildings, Gray's Inn, to the *Building News*, May 15, 1882, says: "I cannot imagine anything more simple than the very practical lines laid down by your able author, Mr. Davies, who I consider has given to the plumbing trade a first-rate method of setting out the principal part of their work."

Another plumber writes to the above journal, May 5, 1882 and says: "Had such men as Mr. Davies stepped forward some twenty years ago, with their systematical teaching, we at this time should be in a far better position. Mr. Davies' plan is the correct and proper method for every plumber to adopt."

The following is a copy of a letter sent to the *House Decorator and School of Design*, dated April 22, 1881:—

"SIR,—Kindly allow me, as a subscriber from the first, to express my best thanks to Mr. P. J. Davies for the valuable and prompt information I received from him on June 26, inst. The advice about work he then gave me I find, after a good, fair trial, gives every satisfaction, and shall count on him being one of the best friends of a young plumber. By inserting this in your valuable paper you will greatly oblige.—Yours respectfully, J. JOBSON."

The following is a letter to the *Building News* of 18th October, 1882:—

"SIR,—I beg to offer my thanks to you for the practical articles which have appeared in your journal on plumbing. They are very good and practical to the back-bone, and have been the means of perfecting many a plumber. I want to know whether you intend to give a few articles on pump-work, as this is very much needed, especially amongst the working plumbers of London, for they very rarely get a chance to see anything of this branch until the job has to be done. Of course, full-paid plumbers cannot very well say that they cannot do it; otherwise the 'sack' is the result. I am told that Mr. Davies is a first-rate country hand, and, if so, he is the very person that can lay down some very simple rule whereby the London plumber could do a pump job. What is wanted is an insight into the old pumps, especially for repairs; the fixing of a jack and also a lift-pump, the size barrel for a man to work easily, and the size of air-chamber for the pump. I am sure if you will let us have something of the kind, you will, as you have done by publishing the other articles (especially the lead-burning, which I asked for), bestow a great favour upon the plumbing trade generally. I should not like to in any way interfere with Mr. P. J. Davies, but shall not think his articles are complete without pump-work and water supply generally.—I am, &c., "PLUMBER."

"Model-buildings, Mint-street, Borough,
October 9th, 1882."

In another letter to the *Building News* of June 27, 1884, under the heading of "Plumbing," written by S. R., may be seen the following, "I do not believe that there is any work on practical plumbing except Mr. Davies' articles in this paper. I understand 'practical' to mean a work in which full and ample directions are given to the intelligent amateur. That is just what several pretentious works do not give."

CONTENTS.

NOTICE.

All *technical* enquiries respecting this work must be made and addressed to the author, who is willing to answer any questions relating to the subjects contained, and who may be consulted upon any technical question on Plumbing and House Drainage.

Address, P. J. DAVIES,
78, Earl's Court Road, Kensington,
London, England.

STANDARD PRACTICAL PLUMBING.

LEAD, AND ITS MANIPULATION.

LEAD was probably discovered by the accidental lighting of a fire on the ground. Saturn was the ancient name given to this element, which has been known from the most distant time, probably long before any other metal. It was common at the time of the Exodus. Its easily accessible and abundant ores possess many valuable qualities calculated to make it noticeable by uncultivated races. We read of the Israelites taking leaden spoils from the Midianites and ordering the same to be melted up into leaden statues. In fact, we read of lead in the Bible as a very lasting material for *letters*. Tablets of lead were anciently used to write upon. Pliny speaks of lead leaves for books. The triumphal song of Miriam, 1491 B.C., says, "They sank as *lead* in the mighty waters," which proves she knew its property of density and its consequent value to the ancient Egyptian fisherman.

The Age of Lead.

This must be judged by that of the rocks. Lead is found in the secondary formations, in the primary and transition rocks (except trap and serpentine); in porphyry, syenite, the lowest sandstone, and occasionally in coal strata.

The World's Production of Lead in 1881.

Herr Landsberg, the general manager of the Stolberg Company, has, in an annual report to his company, given an estimate of the production of lead in Europe for 1881. The following is Herr Landsberg's estimate for Europe:—Spain, 120,000 metric tons; Germany, 90,000; England, 67,000; France, 15,000; Italy, 10,000; Greece 9,000; Belgium, 8,000; Austria, 6,000; Russia, 1,500; total, 326,500. Herr Landsberg estimates the production of the United States at 110,000 tons. As the output of Mexico, South America, Canada, and Australia is small, it is probably safe to assume that the world's production is about 440,000 tons of lead. This does not include China, which is a heavy consumer of lead, and is not unlikely a producer of some importance; nor does it include Japan, of whose output we have no figures. It will be seen, therefore, that the United States takes second rank among the lead-producing countries of the world.

Galena, or Sulphide of Lead,

The above is the proper name for lead ore. It is widely spread over the globe, and is dug out of the earth, washed, pounded, and laid in heaps like so much clay, mixed with fine coals and a little quicklime, and the lot fired (like so much clay for ballast). After the batch is all roasted at a moderate heat, about one-half is converted into sulphate of lead; the sulphate formed having been mixed up with the unaltered portion of the ore, increase the temperature rapidly, so as to flux the two together, which converts the mixture into sulphureous acid gas, which escapes, and pure lead is left behind. In this process the sulphur of the unaltered galena mixes and combines with the sulphur and oxygen of that which is oxidized.

Ores of Lead.

The following is a table exhibiting a view of the different states in which this mineral may be obtained:—

First, Sulphurets.

1. Galena.
2. Blue Lead Ore.
3. Black Ore of Lead.

Second, Oxides.

1. Earthy Ore of Lead.
2. Arseniated Protoxide.
3. Arseniated Peroxide.

Third, Salts.

1. Carbonate.
2. Muriacarbonate.
3. Sulphate.
4. Phosphate.
5. Molybdate.
6. Arseniate.
7. Arseniophosphate.
8. Chromate.

The first is the most valuable, and nearly all the lead of commerce is obtained from it. It is found in abundance in almost every part of the world. In England we get large quantities from Cumberland, Devonshire, and Derbyshire. We also get splendid lead from Spain, called soft Spanish, used for caulking iron pipes. We also get large quantities from America. The ore is diffused through more or less, with dein-stone or gangue; 100 parts of pure galena comprises 86·55 lead and 13·45 of sulphur. In some parts of the world the lead ore may be dug off the surface of the earth, which would account for its very early use.

Galena is often impregnated with other metals, such as silver, iron pyrites, antimony, gold, &c. Other bodies are often found with galena, such as blende, mispickel, fahlore, calamine, quartz, dolomite or pearl spar, barytes, fluor spar, calc spar, and many other bodies. All these substances have to be got rid of in order to obtain pure pig lead.

Much silver is obtained from lead, and as much as one per cent. is at times, though very rarely, extracted from it.

An ore containing eight ounces of silver per ton is a rich ore.

An ore containing two ounces of silver to the ton may be worked for its silver profitably.

There are various methods of obtaining the silver from the lead according to the country, but that now generally

used is known as Pattinson's process which will be spoken of hereafter.

Returning to the lead ore, let us see from whence and how it is obtained. The first question has been partially answered, namely: It is dug out of the earth, and it is found in abundance in almost every part of the world. The Cornish miners have always been experts in tracing mineral trail.

When they trace the mineral from the bottom of a valley upwards it is known as shoading, and the round bits of mineral so found are known by the name of shoad stone. When they dig or bore for the mineral, it is known as costeaning. They dig or bore the holes at right angles to each other in the supposed direction of the lode. When dug they often drive headings into each other; in fact they thoroughly honeycomb the earth below, and examine it with the keenest attention. Afterwards, should any mineral be tracked, the miner's next job is to trace the direction of the vein or lode, often driving or tunnelling an adit which shall act as a working entrance, and drain the mine at the same time.

The lode is thus tracked often from the bed of a river to the highest point of a hill, or to what is known as the "broil," or head of the vein.

Shafts are often sunk through the side of a hill, and so the miners are enabled to meet each other as directed by their "Captains."

I may mention that each lot of men, from foreman to master, has their peculiar title. The principal man of business, as may be expected, is the "Purser." The man directly under him is the "Captain"; the men under him are the underground and "Grass Captains." The work set aside for these latter men is to superintend the preparation, cleaning, and dressing of the ore, and other work on the surface; hence one reason why they are called grass captains. The captains look after the pumps, the timbering of the chambers, shafts, galleries, &c.

There are two classes of miners, known as the underground and surface men. The underground men are divided into two gangs, "Tutmen" and "Tributers." The tutman sinks the shaft and cuts the underground road or adits, galleries, &c., whilst the tributers make use of these roads to get the precious ore to the surface.

These tributers in reality are speculators. The money (except the sist money) they earn is by percentage, and varies according to the market, and according to the mineral, which at times is very widely different. Often they can earn 13s. or 14s. in the pound, and at other times not 6d. in the pound.

It may interest you to know in what way the miner goes to work. I will tell you. His costume when at work is a tight-fitting flannel suit, consisting simply of a shirt, trousers, cap, and strong shoes. He has a broad-brimmed hat, with a light in the front, usually a candle, and a lump of clay to cement the candle to the hat. Fully equipped, away he goes on his rout through adit, well, pit, or shaft, at times clinging to ladders, &c., perhaps first on one stage then on another. At times not a breath of air is to be felt. Nothing can be more injurious or dismal than a journey through these mines by one's self, to say nothing of the difficulty and tediousness of the task when exploring the same. In fact, to a stranger my advice is, not to attempt to go too far at one journey, more especially if of a weak constitution.

I have been in many lead mines, and can say that of all places I know (except a 3ft. barrel drain), the lead mine is the very worst to explore. Should you like to visit a lead mine, I recommend you to take a trip down to the famous Tamar lead mines, near Beer Ferrars, on the river Tamar, dividing Devon from Cornwall.

Suppose yourself to be descending into a mine, and at last to have reached the bottom. The first thing is to stoop and make your way through the narrow levels. Perhaps after a few minutes' walk you will be startled by hearing sounds; and, greatly to your surprise, you will find a miner at work. You will see something glistening in the dirty-looking lead ore. These may be in lumps or otherwise. Perhaps it is an ore which contains much silver; then this ore will not have such a shining, speckled appearance. Perhaps the ore is most beautifully spangled. This is ore without much silver, and is the purest galena, especially if found in bulky batches. The miner perhaps tells you that he is in a limestone rock, and is doing well; or perhaps he has just hit upon sandstone; here his labours cease. It might be that he has come across a bed of slate; this is sudden death to his work.

He may tell you that he is at work on the left or right hand side of such and such a hill; or that he may be working under the Tamar river, and that the lead ore is generally found slanting to the left or right of the rock; that he likes it to continue to dip, etc. He will also tell you that a lode is simply a fissure or crack in the strata, filled with a variety of minerals, such as crystallized silica, or quartz, or fluor spar, etc. He will also tell you that there is no certainty with mineral veins; that they run in an easterly or westerly direction, and that they vary from a very fine layer to 20 or 30 feet in thickness. He will perhaps say that the "deads" are so great that it is not worth working, meaning that it is nearly all rubbish. These "deads" are often seen in great heaps, like the earth thrown up in a quarry field, etc. The miner will most likely also say that there is a miner or two at work below, and perhaps above himself.

Caution!—Remember this, that you may, before you get back, experience a severe attack of cramp; or if not during the journey, you will when you retire to rest at night. You pass on; next you come to a winze. This is a great hole or perpendicular shaft, used to connect the galleries. Here sometimes the greatest care is necessary to keep from falling below. This winze, at times, also acts as a ventilator to the galleries. I may add that these winzes are nearly always infested with carbonic acid, and that the ventilation is invariably bad; consequently, the lead miner's life is but a short one, though, so far as outward appearances go, the miner may seem to be a strong, robust sort of man. For my part, I say that there is no reason why a lead mine should not be properly ventilated; and I would have it enacted that they should be always worked on a principle that would give perfect ventilation.

The lead mine is worked on a somewhat different scale to anything I know of. A mine, divided by galleries and winzes into compartments, say 30ft. long and 60ft. high, known as "Pitches," are let by "Dutch Auction," or leases to say three to five miners, for a matter of three or six months. A rich vein may suddenly be met with; or, on the contrary, a rich vein may, owing to some subterranean freak of nature, have taken a heave, or dwindle away to nothing but "deads." Or, perhaps it has gone up or down, to the delight of the tributers. Sometimes a lode which is a very profitable one "takes horse," by being divided by another lode of nothing more nor less than "deads." Perhaps it is all "Fluckans" (slate clay). Here the miner must search for his rich lode. He may not like to proceed with this search, though it is perhaps within a few feet of where he is at work. He becomes disheartened with his pitch, and resigns his work on payment of a fine of twenty shillings.

Of course the ore has to be brought to the surface or grass, which may be and is done in many ways.

Now, supposing you to have made a thorough examination of the mine, and are again on the "grass," you will want to know what is done with the lead ore. Now, as the galena when found is scarcely ever in a sufficiently pure condition for roasting, it has to be sorted and cleaned from

a lot of earthy matter, sometimes by "hand dressing" or by the use of sieves, etc. At times it is thoroughly washed in sieves and troughs of water, the ore being stirred with shovels, etc. This is known as the "standing buddle" system; it is something like washing sand for plasterers' use, etc., but when there is a plentiful supply of water the ore may be advantageously washed in the troughs. This is known as the "running buddle."

The next operation is the crushing, breaking, powdering, or pounding of the ore. This may be done in various ways, with stampers, with mortar and pestle, or with a regular steam crushing mill.

After the crushing or stamping is completed, the ore is washed, and the fine ore is carried forward through a fine sieve, etc., and the fine ore allowed to settle in the pits, etc., which are often connected to the stamping mill box.

Of course the object of the stamping and washing is understood to mean that it is necessary to have the ore small and clean, or free from the "deads."

Next is the "nicking buddle." This is simply a trough at the head of another long flat trough. The first trough is something like the head pan of a frame or casting table [see Fig. 12], and the second trough is like the table. At the foot of the second or long trough is another trough like the foot pan of the table.

The ore is put into the trough, and a good flow of water is made to play on it. The ore is next knocked about with a kind of scraper with long handle. The water in this way carries off all the earthy matter, and leaves the mineral behind. Next is raking the ore. This is only another kind of "nicking buddle," for the better cleansing and detecting the finer particles of ore. Here the ore is placed on a shelf, water is freely admitted, and by constant and steady agitation the dirt is carried away, and the heavy ore left upon the floor of the rack, which is also called a cradle. To conclude, I may say that this system of washing is based on the principle of the different specific gravities of the earth and ore, the best ore being the heaviest. After all this is done the ore is mixed in certain quantities, and is roasted in a reverberatory furnace, and so the galena is reduced to its metallic state.

The lead ore is spread out over the hearth of a reverberatory furnace. The furnace being red-hot, the heat soon causes the mineral to flow, and on its being stirred about, in order that the air may have free access to the sulphuret of lead or galena, it converts it into a sulphate of lead. Now the fumes of lead convey a considerable quantity of the metal away, sometimes as much as 10 per cent. The flues, therefore, should be of some considerable length, so as to condense the fumes, and thus catch the metal held in the smoke for resmelting and otherwise treating.

After the roasting has been continued for some time, the old skimmings, or what a plumber would call dross, from the last lot should be again thrown into this batch, and well stirred up; then run the lead off. Next the fire is reduced, and some quicklime thrown upon the lead, which produces silicate of lime, and sets free the oxide of lead. Next raise the fire and run more lead off. Now throw more lime on in excess; this causes the slag to solidify, and it can be easily removed when another batch is to be worked as before.

I should state that there are various kinds of hearths built, according to the country.

Separation of Silver from Lead.—English Cupellation.

There are various methods for the separation of silver from lead. This process is conducted in a kind of reverberatory furnace, with moveable hearths. The hearth is formed of an ellipsoidal ring of iron, with supports across the bottom to form a kind of nest, which is lined up with bone ashes, moistened with a solution of pearl ashes, sufficient to make the powder slightly cohesive. This bed is inclined towards the centre, and into a point of about one inch in surface. After the hearth has stood for a week or ten days to dry, it is ready for use. This oval and taper-shaped hearth is then put into a reverberatory furnace in such a manner that the flames will play over its surface. At one side or end is an air blast, driven by a fan, etc., fixed in such a manner that this atmospheric blast can at all times play upon the surface of the lead; a jet of steam is also at times introduced to condense any fumes passing over the hearth.

After the hearth has been brought to a temperature of, say, a dark red, the lead, which should be kept fluid in a pot close by, is poured into the hearth, and the blast put on. Now raise the fire until it reaches a bright red heat; then the formation of litharge, by reason of the atmospheric blast, rapidly takes place; the lead is, in reality, being reduced to dross, which is allowed (by the blast) to be blown off.

This blast answers two purposes, viz., it keeps the surface of the lead clean, so that the fire may better act upon it, and at a certain oxidizing heat; it also conveys fresh oxygen to oxidize the surface of the lead. As the formation of the litharge takes place, so it is by the blast blown off, and is collected to be again converted into metallic lead, which will be spoken of further on.

As the lead is thus reduced, more fresh fluid lead is put upon the hearth, which should be kept at a constant depth. The hearth should hold from five to six cwts. of metal, which may be reduced until there is no lead left. Here the silver will be seen in its bright fluid state, which will remain.

When four or five tons of lead have been thus reduced, and the mass in the hearth has been concentrated until it contains about eight per cent. of silver, the fire should be stopped, and the hearth withdrawn, and the contents run into moulds. Then a second lot of fresh lead should be treated as before. The cupel should last forty-eight to fifty hours, and reduce eight or nine tons of lead, more or less.

The Secondary Operation.

The concentrated lead having the eight per cent. of silver now requires especial treatment. The cupel as before used is brought to a brighter red heat; 500 or 600lbs of lead are, as before, melted, and put into the hearth, and the strong current of air applied as before. The litharge flows off as in the first stages of reduction, until about three tons have been again reduced. Here we get something like 500lbs. of silver. The adding of fresh rich lead is stopped, and the silver allowed to purify with the heat.

Here a splendid phenomenon takes place, viz., the "brightening." The fire is then stopped, and the silver allowed to cool slowly. The lump of silver is then taken out, and ready for refining. The litharge produced by the last lot of reduced lead is rich in silver; this litharge is then reduced to metallic lead, and usually contains thirty or forty ounces of silver to the ton of lead, which is treated by concentration; then, after this, the lead is converted into litharge, when silver will remain. After all the silver has been obtained from the lead, let us see what is the use of litharge.

Pattinson's Process.

I have explained one method of extracting silver from lead, and how litharge may be formed, and the manner in which it is again converted into metallic lead, but have not told you the method of extracting silver from lead by Pattinson's process, invented in the year 1829, which really in England saves on the average from two to three thousand ounces of silver from being thrown away annually.

Pattinson's process is simply a method of skimming the

lead at a low heat. Three or four tons of lead are melted in a pot (called a kettle), then it is allowed to cool down gradually and equally; by so doing a number of small crystals form in the mass. These crystals are nearly pure lead, whilst the other fluid contains proportionately more silver. If the crystals are lifted from the pot with a perforated ladle, the argentiferous fluid will fall through, and the poor lead may be put into another pot for another melting down and skimming, because in the first skimming all the silver has not been removed. Notice: The lead round the sides of the pot cools first. This must be broken away and thrown back into the pot, and kept in small lumps. Now if the poorer lead be again run down, and again allowed to cool, a second skimming can be performed, and the lead lifted by the ladle is so much the poorer from silver, whilst that left behind is not so rich in silver as that left in the first pot; the crystallized portion of the lead is subjected to this treatment several times, and so it becomes poorer and poorer until at last there is not any silver to be obtained from it, when it is turned out as commercial lead. The lead left in the pot is subjected to this kind of treatment several times, until at last a very rich lead, highly charged with silver, is obtained. The rich lead is then sent to the cupelling furnace, and reduced to litharge, as before spoken of. I should say that from ten to twelve pots are often used, all set in a row, for this purpose. Say that you have a No. 1 pot, which is usually the middle one, holding eight tons of lead, and the lead to be just crystallized; the skimmer is then filled with this crystallized lead, which is brought up, and for a few seconds allowed to drain: when with a skilful twist of the wrist the contents of the skimmer is thrown into pot No. 2. The laddle is re-warmed and cleaned from lead, and the skimming again repeated until, say, four tons of the metal have been skimmed off into pot No. 2. Suppose that eight ounces of silver to the ton were in your first pot of eight tons of metal, but at the first skimming you skim off four tons which have only two ounces of silver to the ton, here it is plain that the first pot must be proportionately so much the richer. Let the rich lead be put on the left-hand side, or in pot No. 3, and proceed to melt down and skim another eight tons. Here you get eight tons of fine rich lead and eight tons of poor lead; the latter only has two ounces of silver to the ton, whilst the former has fourteen ounces to the ton. Now remelt the lead in pot holding the fourteen ounces to the ton, and skim it with the same proportional success or gain for silver, and throw it into another lot of pots. By continuing this process you get the lead exceedingly rich in silver, and when there is as much as 300 ounces of silver to the ton, it is ready for the cupelling furnace. Sometimes the lead is brought up with 600 ounces of silver to the ton before taken to the cupelling furnace.

Plumbic Oxide, Massicot, or Litharge (Pb. O.)

This, as I have already explained, is obtained from lead by freely exposing it in a molten state to the oxidizing influence of the common atmosphere; and, if the temperature be kept below the melting point of the oxide produced, a yellow powder, "massicot," or dross, will be produced; but if the heat be raised sufficiently high to melt the resulting oxide, then the colour will be a yellow or a reddish yellow crystalline mass, which is known as litharge. These two products differ widely in certain physical qualities, but chemically they are identical with each other.

The manufacture of "massicot" is as follows: Upon a flat hearth, and in a reverberatory furnace or oven, is exposed the metallic lead, which should be kept at a low, red heat; the film of oxide, or dross (which is the massicot), must be removed as it is produced. After this it is freed by grinding and subsequent levigation. This grinding is done under edge stones, which reduces it to a state of yellow-coloured fine powder; it is then again levigated or washed, whereby the finely divided massicot is carried in suspension by the water, and deposited in a settling vessel, from whence it is collected.

Red Lead—$Pb_3\,O_4$, or $2\,Pb\,O + Pb\,O_2$.

As the plumber has much to do with red lead (also known as minium), I may add that massicot is the basis of this pigment. The colouring is conducted in a furnace similar to those described. The massicot, or dross, is laid upon the bed of the furnace and carefully heated to a temperature below that of the drossing stage, or between 500 and 600° F., at which heat it is exposed to the atmosphere. By continual stirring for about forty-eight hours, the hot samples get to a *dark* red, which, on cooling, will change to a bright red. At this stage close the oven, and let it *gradually* cool; after this, grind and sift it for use. Pure red lead can be detected by heating it until it assumes a yellow tint; but the brick-dust and other ingredients used in adulteration will be of other colours.

To return to our litharge. We have seen how to make it, but now it is required to bring it back to its metallic state.

Litharge melts at a red heat to a clear, transparent, orange-coloured fluid in the reverberatory furnace with about 10 per cent. of stone coal. The furnace is formed of a ferruginous sand which is agglomerated by a strong fire. On a large scale the charge of litharge is, say, three tons. This is mixed with coals and introduced at once. Towards the end of about five hours the charge is well stirred, so that the whole may be brought into close contact.

Here the charge is made into metallic lead, and poured into pigs ready for market, &c. About three tons of litharge will produce 43 cwt. of good lead at a cost of, say, 2/9 per ton, which is principally for labour.

White Lead. PbO, CO_2—or Carbonate of Lead.

This is manufactured by two different methods. The oldest is the Dutch method, which consists of exposing thin sheets of metallic lead to the combined action of carbonic anhydride, water vapour, acetic acid, and atmospheric air, assisted by slow, gentle heat of from 107° to 140°. The components are 112 parts by weight of lead and 22 of carbonic acid.

The Dutch method is carried on as follows: The lead is curled up and put into small glass or earthenware pots which contain about a pint of crude vinegar. A stack of these pots is then placed in horsedung pits, spent tan, &c., then as above noticed a certain heat is generated by the manure. The vapour of the acetic acid thus soon acts upon the lead, and in about forty-eight days the surfaces of the sheets of lead are transformed into scaly masses, which scales are the carbonate of lead. They are got off the metallic lead by bending the sheets backwards and forwards or otherwise.

The carbonate of lead thus obtained is washed with water, ground fine, and dried, after which it may be ground in oil. Carbonate of lead is insoluble in water, but may be dissolved in acetic or dilute nitric acid.

I may explain the theory of the above process as follows, which should be thoroughly understood by my reader, because then he will be better able to understand why lead pipes, &c., are so often holed and destroyed by the action of certain chemicals:—

The vinegar vapour which is raised by the fermenting heat simply acts as a carrier between the carbonic acid, which may be evolved from the tan and the oxide of lead generated under the influence of the acid vapour, a neutral acetate, a subacetate, and a carbonate being produced in succession. This chemical action slowly travels from the surface of the lead inwards, or, in other words, this chemical action is due to the fact that, firstly, a lead acetate is formed, and the acetic acid is slowly forced out from its

combination by the carbonic acid which is evolved from the putrifying organic matter, and thus it is enabled to combine with another portion of the lead which lies beneath the scales which were first formed.

There are other methods of making white lead. The following is of a more recent date, and consists in forming subacetate or subnitrate of lead, which is done by boiling powdered litharge with the neutral salt. Then bring this solution into contact with carbonic acid gas. The excess of oxide previously taken up by the neutral salt is instantly precipitated, or thrown down, and this is the white lead.

The solution is again boiled with litharge, treated with carbonic acid gas, and may be worked over and over again.

How to detect pure white lead: Dissolve the lead in nitric or acetic acid, and precipitate the lead with sulphide of soda. If chalk be present it will give a white precipitate, if oxalic acid, be added to the fluid. If sulphate of lead or sulphate of baryta be present, this substance will not dissolve in the above acids.

The Use of Lead.

The uses to which lead was put by the ancients were much about the same as at present, save and except that awful messenger of death, the bullet. I would that we were for this reason still in the "golden age," when, as Ovid says:

> "No walls were yet, nor fence, nor moat, nor mound,
> Nor drum was heard, nor trumpet's angry sound"—

instead of being in this age of iron and lead.

We read of leaden pipes from the very dawn of history. They were much used in the olden cities of Asia, Egypt, Greece, and Syria. David used leaden pipes; Archimedes used lead pipe and engines to distribute water in Hiero's ship. The terraces and gardens of Babylon were supplied with water through leaden pipes. Lead was also used in other ways about these terraces. What I consider to be most extraordinary is that the ancient plumbers generally made their pipes, as we make ours now, namely in 10ft. lengths, *which is supposed to have originated*, though erroneously, with the draw-bench in or about the year 1800. Constantinople, for many ages past, has been supplied with water through leaden pipes. Lead is much used by the painter; glass maker, and potter; also by the chemist for many purposes.

Sheet Lead as a Covering for Roofs.

Sheet lead as a covering for roofs we can trace back to the early age of building, which, according to Ovid, must have been in the "silver age," and it has been uninterruptedly used ever since. We also can trace the art of using the table or frame for casting sheet lead to an immense antiquity, and the modes of laying the lead on roofs have not in the least improved, but, on the contrary, inasmuch as that half the lead is now spoiled by the fancy lead layer setting in the angles too sharp with box tools, to give what some may call a finish to the work. Though I for one like to see *this* class of work, *if it is practised without detriment to the lead.* Hundreds of times have I seen 7lb. lead distressed in the angles to 2 and very commonly 3lbs. lead. This will be thoroughly spoken of under the head Lead-laying.

Nature and Properties of Lead.

Symbol Pb (according to Mr. G. Fownes, Ph.D., the equivalent of lead is 103·56). *Combining weight*, 207. *Specific gravity*, according to circumstance, say, 11·45. *Colour*, a bluish grey tint. *Density* reduced instead of increased by hammering, becomes hot and opens its fissures. *Fusing point* differs, generally about 612°; it always lies between 594° and 635° Fahr. If heated to fusion in the air it soon becomes covered with a play of iridescent colours, resulting from the formation of a thin pellicle of the oxide. If a very strong heat is applied, it boils and evaporates, and if exposed to the air, it smokes and forms a very pretty sight. It affords a grey suboxide, which clings to anything cold. *Hardness*, 5½ (may be scratched with the thumb nail). *Malleability*—It occupies the seventh place amongst the metals. *Tenacity*, extremely low. A wire 1-13th of an inch breaks with a 28lbs.' strain, or, what may be the general rule, less than 1-20th that of iron. *Elasticity*, very little. *Sonorousness.*—It is not sonorous like many other metals, although it answers the purpose much better than iron pipes for speaking tubes, which is owing to the smoothness of the bore. *Crystallization.*—Lead when cooled forms imperfect octahedral crystals [see also the Silver Tree]. It contracts on cooling; it becomes permanently enlarged by repeatedly heating, as can be proved by milk pans. Lead transmits heat very slowly. Of the seven common metals it is the worst conductor; therefore it is good for hot water pipes, especially when used in long lengths, though not generally known.

Chemical Properties.

Lead is soluble in nitric acid (Pb^2NO_3). This is the most important of all soluble salts of lead, and is obtained by dissolving as much lead in the warmed nitric acid as it will take up. This is pure white and it crystallizes in octahedra and dissolves in eight parts of water, and when heated strongly it yields red fumes of NO^2. Lead dissolved in aqua-regia is *chloride of lead*. *Lead Tests.*—Lead may be recognised, 1st, by the black sulphate soluble in diluted nitric acid; 2nd, by the white insoluble sulphate; 3rd, by the yellow iodide and chromate; 4th, by the reduction of the metal in the form of a malleable bead, when any of the salts are heated before the blow pipe with a reducing agent. Lead can be detected in many ways by sulphuretted hydrogen [see Suspected Water]. Lead is capable of combining with most metals. *Mixed with a sufficient quantity of quicksilver it remains liquid*—very important to the lead-worker, but not known. Lead exposed to the action of damp air becomes dark coated, which is protoxide Pb.O Let the action be continued and white carbonate $Pb.CO_3$, or white lead, will be produced, which is caused by the carbonic acid in the atmosphere. Therefore it is desirable to keep lids (which should never be of lead) on lead cisterns, and also to prevent carbonic acid getting into the lead cisterns, &c. Lead is not affected by dry air; its bright surface will remain permanently.

Suspected Water (with Lead and Lead Test).

Having lead in solution, can be determined by passing a current of sulphuretted hydrogen (hydrogen sulphide) (or hydrosulphuric acid) (symbol H^2S), which is best prepared with, say, 1 oz. of sulphide of iron, FeS, and about 2 ozs. of sulphuric acid diluted in about ten parts of water. Sulphate of iron will also be formed thus—$FeS + H^2SO_4 = Fe SO_4 + H^2S$, where two atoms of hydrogen change place with one of divalent iron. This forms a colourless gas and is a strong poison. It stinks like a stinking water-closet. In fact, this is, when mixed with other gases, one of the most poisonous found in sewers and closets. You see that it will detect lead by the same reason lead will detect this gas. It turns lead brown and black, which can be noticed in plenty of rain water pipe joints (if they are painted a light stone colour and connected to sewers).

Lead for Closet Traps, Soil Pipes, &c.

These traps and pipes should be perfectly ventilated to prevent corrosion. To prevent the decay that must take place through chemical action on lead, perfect ventilation

must be maintained. So important, indeed, is it, that a well-ventilated trap will last twenty times as long as one not ventilated, as traps having no ventilation are condensers, and the action of the pent-up carbonic acid, in conjunction with this condensed water, sets up a very powerful corrosion, so that the surface of the trap above the water-line becomes one mass of, so to speak, ulcers, and when, by the action of the closet, the water is disturbed in the trap, it dissolves this oxide of lead; then this solution, formed on these corroded or eaten parts, rapidly absorbs more carbonic acid, and thereby creates a quantity of hydrated oxy-carbonate of lead ($PbO, HO+PbO, CO_2$), which is deposited in white scales. [See Corrosion of Lead].

Lead for Pipes and Cisterns.

[*See Cisterns*.]

It is in some cases a good plan to fill the pipes or cisterns with a solution of phospate of soda, $2\ Na\ O,\ H\ O,\ PO_5+{}_{24}H\ O$, which forms a protective film or crust upon the lead. This crust is well-known to the lead worker, but the cause to him is little known. Many kinds of spring water, having salts in solution, especially sulphate of lime $Ca\ O,\ SO_3$, do not act upon lead, whilst others act very quickly and corrode the lead. Of course this corrosion is a deadly poison. If you limewhite out a leaden cistern which has to hold corrodible waters, this whitewashing will give a crust to the lead, and often preserve the cistern from the attacking chemicals held within the water.

Corrosion of Lead.

[*Also see White Lead, Lead for Closet Traps, Lead Cisterns, &c.*]

Lead in connection with dissolved organic matter soon becomes corroded, and a nitrate of lead is the result (of course poison). Lead is often eaten away by mortar, cement, and the like substances having carbonic and other acids lurking about. Lead traps are often eaten away by the action of carbonic acid and sulphuretted hydrogen from sewers. [See account of Sewer Gas on Lead Traps.] Ventilation is the best retarder. Lead is quickly eaten away or perforated when in connection with wood, especially oak, undergoing rapid decay. This is due to the action of the acetic acid produced by the decomposition of the wood. The carbonic acid of the air and the chlorides and nitrates in the water, often to be seen in places where the ends of posts rest upon lead, especially when the same is covered with water, such as cistern-cover legs or supports. I have heard lead-workers arguing that these perforated holes are made by a grub which is in the oak. The holes are often called grub holes. A piece of slate or glass between the oak and lead will remedy this.

Lead Flux.

Resin, and especially arsenic, but if an excess of the latter the lead will become poisoned, or "rotten," as it is sometimes termed. Arsenic is used in making shot when the lead is required to run very freely. Common salt will facilitate lead spreading when casting. The salt should be strewn upon the bed or mould.

Lead Experiments.

These are given with a view of leading the industrious student or plumber into more scientific research necessary for his calling. I should here notice that the observant plumber will immensely improve himself by practising the same. I intend to give scientific experiments on every branch connected with the trade, especially in pneumatics and hydrostatics.

EXPERIMENT I.—*Lead Tarnishing*.—Take a piece of sheet lead and shave the surface perfectly clean and bright, then breathe on the same; it will immediately change colour and become tarnished, when it cannot properly be soldered. Cisterns shaved in this manner nearly always leak; therefore, after shaving lead work, the greatest care should be taken to keep the face well away from the work until after it is *touched*, which prevents tarnishing. We take into our lungs oxygen, and breathe out carbonic acid gas (which is proved by this simple experiment). The dampness of the hands will also tarnish lead in the same manner. The steam from wet wood when soldering will also do the same thing; therefore fix paper between the wet wood and lead when soldering.

EXPERIMENT II.—*Uneven Expansion*.—Take a piece of sheet lead, say 24in. square, subject the same to sufficient heat to cause it to bulge in the centre, and continue the heat until it just begins to melt; then cool same, and the same will be porous, and if beaten or bossed out with a mallet, it will break in all directions. The cause of this is that the molecules around the centre of the heated place rapidly urge the outer molecules into a very compressed state, and these when cool do not go back. The lead is then unequally crystallized, and hence the porousness. This experiment proves that sheet lead should never be made unevenly or excessively hot after milling; neither should it be made too cold. The cracks in gutters, &c., are caused by this uneven action of heat. Cast lead (which again is coming into vogue for our best class of roof work) is therefore the best for gutters, where the same are subject to high and low temperature.

EXPERIMENT III.—*Softness of Lead*.—Take two pieces of 5lb. sheet lead, subjecting them to a heat of nearly melting-point, which will anneal same; then place a common seal of sealing wax between the two pieces of lead on an anvil or other thick iron substance; then strike a sudden blow (not too heavy) with a hammer, and a correct impression of the seal will be obtained, which will form a very good substitute for the original seal; but strike the lead softly, and the seal will break without affecting the lead. This proves that one smart blow with the mallet or other tools (in the proper place) is better and tells more than fifty taps when setting up gutters or working down drips, &c., and especially when fixing pipes. I can always instantly tell a good lead-worker by the manner in which he strikes the lead, as a duffer is always afraid of making bird's-eyes (holes), when he has to pay, if working with others, a fine of 1s., or half a gallon of beer, for each bird's-eye he makes, or take the "bullet."

EXPERIMENT IV.—*Conversion of Lead*.—Take a metal-pot half-full of melted lead, into which throw a lump of brimstone, then stir the lot together; the sulphur will convert the lead into a cloggy mass. This is the lead converted back to its original form, and is called sulphide or sulphuret of lead or galena, $PbSO_4$, lead ore. Then make the lot red-hot, and this changes the same, by which much of the sulphuret becomes changed by oxidation to sulphate—that is to say, some of the sulphur is gone. Thoroughly mix the contents of the pot, and raise the temperature, when the sulphate and sulphuret react upon each other, producing sulphurous acid and metallic lead again. If a little quick-lime be added, the operation will be quicker done. This experiment goes to show that lead should not be melted over a coke or other sulphurous fire, neither should sulphur be brought into contact with lead. Solder melted over a coke fire never works so well as with coal.

EXPERIMENT V.—*The Silver Shower*.—Precipitate a strong solution of acetate of lead (sugar of lead) with hydrochloric acid (spirits of salts), or a solution of salt; on boiling the solution the precipitate disappears, as one part of chloride

of lead dissolves in 135 parts of cold and 33 of boiling water. When cold the chloride of lead again deposits lovely crystals—the silver shower.

EXPERIMENT VI.—*The Golden Shower.*—Precipitate a solution of sugar of lead with one of iodide of potassium; boil the solution. The iodide will redissolve and precipitate in very pretty yellow scales as the bottle cools. The yellow precipitate is iodide of lead PbI.

EXPERIMENT VII.—*The Silver Tree*, sometimes called the Lead Tree.—This is an electro-chemical action of lead and zinc. Suspend in a solution of sugar of lead a piece of zinc. The first effect is the decomposition of a portion of the lead, and the deposition upon the surface of the zinc. It is a displacement of a metal on a more oxidable one, but the change will not stop short here; the metallic lead continues to deposit large and splendid plates upon that first thrown down, until the solution is useless, and the zinc disappears. The first of the lead forms with the zinc a voltaic arrangement of a sufficient power to decompose the salt, the circumstance under which the latter is placed. The metal is precipitated upon a negative portion—of course, that is the lead—while the oxygen and acid is taken by the zinc.

EXPERIMENT VIII.—*Lead Test.*—Write on a piece of paper, with a solution of sugar of lead, any word you choose. Let it dry, and you will be unable to see the writing. Then make some sulphuretted hydrogen gas [see "Suspected Waters"] and bring it into contact with the prepared paper, when the chosen word will come out. The sulphuretted hydrogen is prepared as directed under the heading of Suspected Waters.

How to Dissolve Lead.

Lead readily dissolves in nitric acid, especially if the lead be clean, and the acid made hot.

Lead Poisoning.

This poison may be introduced into the system by breathing it in the form of fumes into the lungs, or by eating food without first washing the face and hands, (especially those who have a moustache), by swallowing it, or by drinking water, &c., which has passed through leaden pipes. A man exposed to the fumes of lead will become so charged with this poisonous metal, that on taking a sulphureous bath, many parts of the body, particularly those beneath the finger nails, become darkened by the black sulphide. The disease will often show itself years after exposure; it first shows itself by the blackness of the teeth, violent pains in the bowels, which occur at intervals, and are assuaged by pressure with the palm of the hand. Sometimes the pains attack the limbs and muscles, and after several attacks the disease perhaps ends in paralysis and death. Sometimes the affection terminates in delirium, occasionally attended by the wildest frenzy, or violent convulsions. *Treatment.*—For mild cases, sulphureous water and sulphuric acid in a weak condition; in severe cases, strong emetics, followed by active purgatives, and cataplasms applied to the stomach; a little chloroform calms the pains. If a preparation of lead has been swallowed administer 15 grains of sulphate of zinc, 30 grains of ipecacuanha, and irritate the root of the tongue, followed by a dose of sulphate of soda, NaO,SO^3+10HO (Epsom salts), which converts the soluble salts of lead into an insoluble sulphate, which is inactive.

Pig Lead.

A pig of lead is 3ft. long, and weighs from $1\frac{1}{4}$ to $1\frac{1}{2}$ cwts., according to district. *Spanish pigs* are about 1 cwt. *Fotder*, or a fodder of lead, should equal $19\frac{1}{2}$ cwts., in London 20 cwts., in some parts of the world 22 cwts., and in some mining districts only equals 8 pigs; therefore, do not be deceived by the term pig or fodder.

THE WORKSHOP AND ITS TOOLS

In order to give a thorough knowledge of the plumbery-work, or lead-working, and also plumbers' work in general, I must first commence in the workshop.

The shop should be light, dry, and roomy, having a fire-place provided with blower and hooks, with links for the metal-pot [as shown at F J, Fig. 12], a place for coals and lead ashes; and a pail, called the "quench pail," for the water to quench the handles of the irons. The bench should be strong and well made, and at least 10ft. long by 2ft. 6in. wide, with its top made of 3in. deal, and it must be firmly fixed 1in. out of the level, falling from left to right. The bench should be provided with a vice made to take off when working soil pipes, &c. Amongst other necessary tools are blocks and falls, or a crane, a couple of *hand-spikes*, or levers, made of wood, generally hornbeam or ash, about $2\frac{1}{2}$in. to 3in. in diameter, and about 5ft. long, and slightly tapering at one end, so as to enter the ends of the sheets of lead; two *wooden rollers*, to roll the sheets of lead upon, about 15in. long by 3in. diameter; and a pair of *hand-irons*. The hand-iron is a piece of half-round iron, about 1ft. 6in. long, with a crosspiece at one end about 9in. long, and a foot at bottom, this foot being simply the iron bent 6in. at right angles. The hand-spike, rollers, and hand-irons are for shifting the sheets of lead. A little *trolley* is very handy for moving sheet lead. This may be of 3in. deal and about 1ft. 6in. long, the wheels being 6in. in diameter, and of cast iron, with a sufficiently strong axle to carry one ton.

Implements Employed in Casting.

Next comes the small *melting-pot*. This is about 1ft. deep and 15in. to 2ft. in diameter, and is set in brickwork like an ordinary copper, with door and damper [see P A, Fig. 12]. This pot is used for making up solder, and melting lead for small castings, such as sash weights, clacks, &c. Set the pot in such a manner that the fire can play all round the sides and bottom, and high enough to allow of plenty of coals being thrown in the fire box at one time.

The Sand Box.

The sand box should be about 4ft. long, 1ft. 6in. wide, and 1ft. 6in. deep, with a lid to keep the sand clean and moist. The best sand for jobbing work is that used by iron founders, which any founder will supply. In default of this, common washed sand with a little loam will do. This box is used for solder-making, and lots of other odd work.

Solder Mould.

[*See* A, B, Fig. 33.]

The plumber's solder mould is generally made of deal, or, properly speaking, this is a pattern which is often made

by a carpenter. To construct it, take a piece of 2in. deal, 1ft. 6in. long and 1ft. 2in. broad, and planed smooth, as at A J, fig. 33. Next make four smooth triangular bars, as at *a*, *b*, *c* and *e*, 1ft. 2in. long with 2in. sides. The ends of the bars should be cut to the same rake as the sides. Nail the bars on the 1ft. 6in. by 1ft. 2in. boards, of course lengthways of the board—say ½in. apart, or so—and at one end of these bars nail a ½in. fillet, which answers the purpose of a runner, as at *h e*, Fig. 33. This fillet or runner allows the solder to run from one triangular channel to another, and should not exceed the thickness given, or trouble will be found in breaking the bars apart [see *h*, Fig. 33], then *e*, *e* is too thick, *h* is notched down. The fillet or runner should also be made a little tapering, to allow the bar to leave the sand. When an iron solder mould is preferred, it can be bought at the lead merchant's; but they are not nearly so good as casting in sand.

Fine Solder Mould.

This is best in cast-iron, and can be bought at the lead-merchant's, or he can get you one to order from the Carron Iron Foundry, Cannon Street, City. This mould may be made as follows:—Take a piece of 1in. board, 1ft. 6in. long and 1ft. wide, and cut a number of half-round grooves, ½in. apart, ½in. wide, and from 1ft. to 1ft. 3in. long, the ends of which should be rounded, in order that the solder may leave the moulds. The grooves are sometimes made triangular instead of half round. At one end can be fixed a handle.

Ladles.

Ladles must be in size proportionate to the work. Small ladles for joint-work and bench-work should be flattened a little at the bottom. This keeps them from tipping over. It is a capital plan to make the handles red-hot, and then

FIG. 1

bend them back, so as to form a kind of double handle for a grip. This shortens the handle, but the same need not be made too short. Such a ladle is shown at Fig. 1.

Soldering Tools.

Plumbers' irons should be in size according to requirements. Cisterns and roof-work require large ones, whilst joint-work requires small. Plumbers' irons should never

FIG. 2.

be made hotter than a dark-red heat, and must be kept perfectly free from scales or dirt, in order that perfect contact between the two metals can be established. The solder should be always wiped clean off with an old piece of felt or carpet after using an iron. If an iron gets scaly it must be cleaned with an old file, called a rubber. The handles must be quenched before giving to the plumber to use. These irons are bought at the lead merchant's or ironmonger's. Such an iron is shown at Fig. 2.

Solder Pots.

The solder pots should be according to the work, and are always to be had of any respectable ironmonger. The handles should be made sufficiently long not to fall on the sides of the pot. They will then keep cool enough to handle.

FIG. 3.

I find the solder pot, Fig. 3, to answer better than those having straight sides, for the simple reason that when placed upon the fire they are not so apt to lose their contents should they happen to get an unfortunate tilt. The reason for using straight-sided pots is, that the solder when cold can be easily turned out when the solder is required to be changed.

Copper Bolts, Bits and Soldering Irons.

Soldering irons or *copper bits* (sometimes called *copper bolts*).—These are made to suit the work, but the ordinary copper bits can be obtained at any lead merchant's or

FIGS. 4 and 5.

ironmonger's. Sometimes this implement is made in the shape of an axe, and is then called a *hatchet bit*, as at A D E, Figs. 4 and 5. The straight bit is shown E F H J K, Figs. 4 and 5. Also see account of Copper Bit Joint Making.

Tinning the Copper Bits.

[*Also see Killed Spirits and Tinning Iron, &c.*]

The copper bit must always have its point or nose perfectly tinned with the same material as that used in the soldering. If resin is used as the flux for soldering, use resin to tin the bit, and the cooler the bit is the better it will tin, providing it is sufficiently hot to melt the solder. If killed spirits are used as the flux for soldering, use killed spirits to tin the bit with, in which case it requires to be considerably hotter. In tinning copper bits for soldering with resin, first file the nose as quickly as possible quite bright; have at hand a piece of tin plate about 4in. square (called a *tin pan*), with some *black* resin, powdered, upon it. With the cleaned nose of the copper

bit, melt a little fine solder, so that it will drop upon the tin pan and resin; then rub the nose of the bit briskly upon the mass of solder and resin, and the result will be that the bit will be tinned. This is termed "putting a face on" the iron, and it is ready for use for lead-work joints, etc. In tinning the bit for soldering with spirits, first prepare the spirits by putting some ordinary spirits of salts (obtainable at most oil shops or chemists' shops) in a gallipot or other earthenware vessel, say quarter full. Next drop into this as much zinc as it will dissolve (this mixture is called "killed spirits," or chloride of zinc). Then having cleaned the nose of the iron free from grease, oxide of copper, smoke, etc., plunge it into the spirits for a second of time only, and immediately touch the bright part of the nose of the iron with solder; the face is then on, and the bit ready for use in soldering iron, zinc, copper, brass, and many other metals. Care must be taken never to get the copper bit red hot, or the face will be burnt off, and the same processes of tinning must be gone through. In all cases before the bit is used the face should be wiped and rubbed upon the tin pan, or dipped into the spirits. The bit can be tinned in many different ways. A very good plan is to rub the nose after cleaning on a lump of sal ammoniac, with a little fine solder; or, instead of using killed spirits, some sal ammoniac dissolved in water will answer the purpose, and the face will last longer for zinc work; or the bit may be wholly tinned by the use of sal ammoniac and solder.

Notice:—The reason why the soldering iron so readily melts the solder is on account of the perfect contact between the two metals. It is not generally known that solder will melt under any hot iron, but unless the iron (or other metal) is perfectly free from oxide, perfect contact between the melted solder and the "iron," (*which is essential,*) cannot occur. When properly cleaned and coated with tin (or solder) the coating prevents reoxidation of the metal while heating, and when so the fluid metal follows and can be directed by the tool; therefore, do not let the iron be made too hot to destroy the tin or solder after it has been once deposited upon the face of the iron, or copper bit.

How to Solder Zinc, Iron, Brass, Copper, Gun-metal, Pewter, &c.

Clean the iron or brass quite bright and free from grease, &c., as you did when tinning the iron, and use killed spirits. Now get a copper-bit, make it hot, file the face, and dip its nose into the killed spirits of salts, and touch the face with some fine solder. This will give a tinned appearance to the face of the iron. Now, paint the prepared iron with the killed spirits, and apply the soldering-iron with solder to the prepared iron, when it will be tinned, and the lot will be soldered or amalgamated together. Use a little killed spirits to the iron or brass when soldering the lot together, viz., if the work does not readily tin.

Wooden Tools, &c.

Mandrels are made of soft wood for making pipes upon, and should be the length of the pipes required, and about $\frac{1}{4}$in. smaller than the pipes, especially large sizes. The mandrel must be a little tapering, say from 1-16in. to $\frac{1}{8}$in. in 10ft. Trumpet-mouth, or waste-pipe mandrels should be made three times as large at the top as at the bottom, whatever length they may be. [See Figs. 330 and 57.] The usual length is about 3ft.; therefore a mandrel 3ft. long, 1in. at the bottom and 3in. at top, will be called a 1in. mandrel, because it is for a 1in. waste-pipe. The *straight edge* is a piece of well-seasoned wood of any required length, corresponding with the length of pipe to be made, its edge being shot perfectly true. This is for trying the edges of the lead when making soil-pipes, &c. *Trap block* [see Fig. 249]. This is a block of wood 1ft. 6in. by 1ft. 3in. by 3in., with a $4\frac{1}{2}$in. hole at 3in. from the one end, and at about the centre of the length, dished 1in. down, and 1in. at the top. The block should have an iron rod through each end to keep it from warping. This block is very handy for soldering work upon, such as service boxes, &c. The *cutting-out knife* [see Fig. 39], or long drawing knife, is a long-handled knife of say 3ft., with a piece of sash-cord to pull it with. This knife requires two to use it, and is employed to cut up sheet lead [see Fig. 38]. *A set of scales* are indispensable in the plumber's shop; they should be constructed to weigh at least 1 ton.

Dummies and Tinning Iron.

Dummies are made to almost every conceivable shape, as shown at Figs. 6 and 7; also as shown at F, G, H, I, J, Fig.

FIG. 6.

187; also at Fig. 181; also at B, 182; in fact, dummies are tools made according to the fancy of the lead worker, and are used to get the dents out of soil-pipes, especially when bending the latter. The best process of making them is to take a piece of $\frac{3}{8}$ in. or $\frac{1}{2}$ in. iron pipe of the length required—say 3ft.—clean or file one end perfectly bright and free from grease or oil, and tin the end of same as follows: Dip the bright end of the pipe into the killed

FIG. 7.

spirits; make the copper bit well hot, drop a little fine solder upon the spirited part of the iron, and rub the iron all round until the iron pipe is the same heat as the copper bit, and if hot enough and sufficient spirits and solder are used, the pipe will be tinned. In all cases this will do for soldering malleable iron together (of course brass or lead will require to be properly prepared, which will be spoken of in turn). The iron pipe being thus tinned, make a hole (with a rounded end) about the size of a hen's egg in some sand, and having a ladle full of melted lead, run it round the tinned end, and the dummy is complete, and may be bent as required. Canes for the handles are often used; they should be notched round and cemented to the lead with resin and brickdust *when the lead is cooling*. Some plumbers trim their dummies as shown at F, Fig. 7, but in some cases the dummy will be found more useful if left square as shown at Fig. 6, and will be none the worse if the back at D, Fig. 6, is not rounded too much, as with a straight back you can strike up a dent with greater certainty.

Subsidiary Tools.

The Pump Hook.—This is a rod of $\frac{3}{4}$in. iron, 3ft. to 5ft. in length, with a screw at the bottom [see H, Fig. 8, and E, Fig. 9] (something like the screw of a gimlet), and a hook formed within 1 inch of the bottom, and sometimes without

the screw, as shown at the dotted lines, A B, Fig. 8. This hook is simply for hooking up long spindle valves, such as the valve shown at Fig. 587, &c. [Also see long spindle valve in Pump Work.] It also has at the other end a flat round top at A, Fig. 9, about 2in. in diameter and ¾in. thick, and a ¾in. hole or eyelet, B, 9in. from the top. The pump hook is used for drawing the clacks from Jack pumps, and can be purchased of any lead merchant. [Also see Setting Sucker-boxes, in Pump Work, Vol. 2.]

PUMP HOOK.

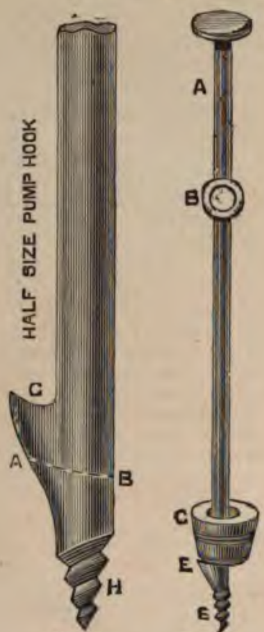


FIG. 8. FIG. 9.

Fire-pot or Devil.—This is madeof various sizes, according to the class of work. For ordinary use it may be constructed of ¼in. sheet iron, about 10in. round and 10in. deep, with a grate in the bottom, the bars of which do not exceed ½in. apart. The fire-pot should stand upon three legs 1ft. long, and should have two or three 2in. holes in the sides for the irons, and an arched piece of iron over the top to hang the pot upon. Various kinds of plumbers' stoves are in the market, but none to equal the old-fashioned shaped "Devil." A sieve of ¼in. mesh and a shovel should be in the shop for the sand-work. The *lead clack mould*, for casting lead pump clacks, can be obtained at the lead merchant's. It is only an iron box in two halves, with the patterns or moulds of the clacks. [See Lead Clack Moulds, Fig. 24]. A *set of stocks and dies* [see my book on Hot Water and Gas Work] is indispensable in the plumber's shop. The best are the solid circular dies, which cut in quarter the time of others. A few *punches* for leather, of various sizes, are always handy for cutting washers. Of *gas tongs*, the old-fashioned are by far the best for work. The *tube cutter* should have three knives, as they are better for cutting out a length of iron pipe. For ordinary work take the two front wheels out and work with one. This plan is less likely to spoil the cutters.

The Force Pump and Analogous Tools.

The *force-pump*, Fig. 10, can be had at the lead merchant's. This is a little hand-pump, made of brass, with a plunger or piston working in a cylinder. The pump has two small valves or clacks, which should be kept free from grit or any other substance that will tend to keep them open. The best form of force-pump is that with a stuffing-box for the plunger to work through. The connection between the force-pump and the pipes requiring to be forced is made with an india-rubber or leather pipe, and the force-pump placed in a pail of clean water, the contents of which are rapidly pumped into the pipe. The *force-cup* [Fig. 11]. —This is a very handy little apparatus made of india-rubber, in the shape of half a ball, with a handle fixed on

FIG. 10. FIG. 11.

the top to press it down with. It is used to unstop wash-basins and sinks, as follows:—Fill the wash-basin with water, having taken the plug out; then place the force-cup sideways into the water, to insure the cup *filling with water* and that no *air* be under its dome: turn it when *under* the water, and place the force-cup over the hole, and briskly press the cup up and down under the water, and nineteen times out of twenty the pipe will be cleared.

The Plunger

Is a piece of stout leather, 3½in. in diameter, screwed on the end of a broom-stick, and is used for forcing water-closets when stopped. The manner of employing it is to force it briskly up and down the closet; not too hard, or otherwise the trap may be spoiled.

Plumbers' Bag.

This is best made out of a new piece of best Brussels carpet, as follows:—Say that the bag is to be of a general size, namely 18in. deep and 16in. wide. Take a piece of carpet 34in. long for making the width, and 24in. wide for making the length. First turn down the top edge 3in. over on the inside, and with some good carpet thread sew this edge well down, then place the carpet edges together, the figure side of the carpet inside, so as to form the width of the bag, and sew this edge one inch in and with *double* thread; after this sew the bottom likewise and the sewing is done. Next get some middling stout half-inch lead pipe to form four eyelets for the cord. The method for making the lead eyelets is by tafting or flanging the lead back. Then bore a hole 4½in. from the outside seam and midway through the deep or 3in. seam; cut the lead pipe off so

that the end will protrude through the carpet, say half-an-inch; now with your turnpin open the end of the lead, and with a small mallet turn the lead over tightly; the eyelet is then complete. Bore three more holes, one of which will come opposite the one made, and the other two at the same distance from the other side. Now turn the bag right side out and it is ready for cording. The bag is carried with a piece of sash cord about six feet in length and three-eighths-inch thick, threaded through the eyelets from one side to the other. Have the two ends to meet and tie on *one side* of the bag; never have the knot fastened so as to be inside the bag; when you are carrying it let the knot end of the cord be taken through and under the cord on the other side, and in such a manner that it will pull the sides together; the cord is then kept together and will ride easily on your shoulders, to say nothing about the mouth of the bag being kept closed. Some plumbers sew on brass rings instead of the leaden eyelets, but I much prefer the eyelets, as they allow the bag to lie flat against your back when it is being carried about. Some plumbers line the bag with leather, &c. Pouches for small tools, such as shavehook, punches, and cloths are made with a little flap, which is fastened with a strap and buckle.

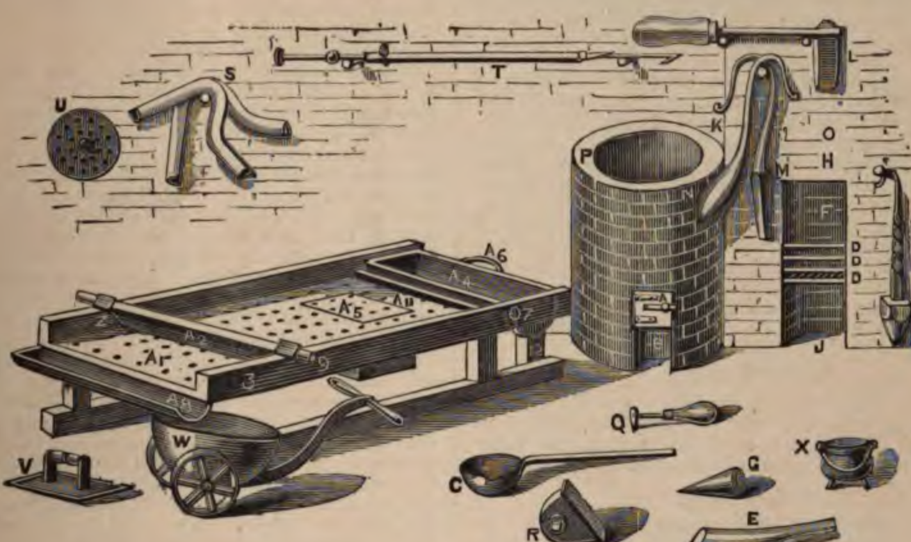


FIG. 12.

The Workshop, in Olden Times known as the Plumbery.

The engraving Fig. 12 shows an old-fashioned plumbery, or plumber's shop. Now compare this with the present style of plumber's shop, and say if there are more than half-a-dozen such shops in London? Next, how many plumbers are there in London competent to work the tool or frame shown on the left-hand side of the engraving, and how many more are there that ever saw such a thing, although one of the best tools that ever plumbers worked with? I think I hear you say that we have no use for such nowadays; but we have, as will be explained hereafter, and I may say that it is only lately that Mr. G. Shaw, Master of the Worshipful Company of Plumbers, fixed one at St. Paul's Cathedral, London, for re-casting the lead of that roof. There has also been one lately fitted up at Westminster Abbey, and every *plumber* should know its rudimentary work, if nothing more.

As the old apprentice boy's primitive work was to fire up the pot, it is clear that, by way of a start, he should know something about this. The pot for casting should be large enough to run down at least two tons of lead; it is set in a top supporting plate of iron 1in. thick, and something like a copper; but care must be taken to set it in such a manner that you can get fire all around the sides and bottom, with a good damper, and at least a 9in. flue. It is most important that a hood should be fixed to convey away all fumes.

There are at the present time several lead-casting jobs going, one at St. Paul's Cathedral, London, also one at the Abbey, Westminster, and at several country churches.

Hints about your Tools.

When putting your tools into the bag, lay them straight and in good order, so that they will ride flat and easy. The ends of rasps, long files, your saw, and such tools as are too long to lie down in the bag, should be put in with handles downwards, so as not to bore holes through the bottom; and when you pull your tools off your back don't throw them down on the ground, &c., to cause them to cut or burst the bottom out; many labourers will do this, and the plumber never has a decent bag or one fit to take on a job. The plumbers' bag should be the pride of every respectable tradesman, and, as a rule, it tells a tale of his tidiness, for if one thing is always kept in order, you may be expected to be careful in others, which is a very great desideratum; another thing is that your tools are always noticed in good shops—that is, whether your tools are clean and in a respectable condition for work.

LEAD CASTING.

"Sheet"-Lead Casting.

Fill the pot before lighting the fire; the heat given off from the metal passes amongst the lead and dries the same. Never put *damp lead* into the fluid metal, or you may find the contents taking wings unto themselves, as the lead did from a large pot which was being used for pipe-laying when a mischievous boy threw a snowball into it. Now, whilst the lead is getting hot, let us examine the frame previously referred to. A1, Fig. 12, is the bed, made with about 2½in. or 3in. deals, having a quantity of 3-16in. holes 3in. apart bored into them; the bed is generally about 12ft. to 15ft. long and about 5ft. to 6ft. wide, having a fall of 1½in. to 2in. in 12ft. from head to foot, A6 to A1 [see engraving]. The stand-up sides are the "shafts," which should be kept quite true and smooth, also protected with a sheath when not in use. A4 is the "head-pan," best made of copper, although often made of iron. This head-pan should be made to work on hinges as at 7; A6 is the tipping-handle, sometimes pulled up with a crane, other times with an iron bar; A11 is a strip of wood to keep the sand up; 12 the rest-prop for head-pan, A5 the sand-box, A8 the foot-pan. In some frames we have a "mid-pan," which is, of course, for short sheets or other castings; but with a very little trouble you can take out one of the bed deals and shift the foot-pan to any part you choose. The height of the frame varies from 2ft. to 2ft. 6in., but the lower the better, as you can reach over to plane much more easily.

The Coach.

This is only a kind of oblong pot, shown at W, Fig. 12, made to run on wheels; it must be strong enough to carry a ton of lead. Its use is to catch the surplus lead which may run into the foot-pan and to truck it back to the pot.

The Frame Sand-Box.

This is shown at A5, Fig. 12, also at H, Fig. 13. It should be air-tight, so as to keep the sand as near as possible to the right dampness; V, "the plane," made of copper, having a very smooth face and turned up edges round the outer part.

The Strike.

This is rather an important tool, made as follows:—Take a piece of dry, solid mahogany about 18in. longer than the width of the frame, and notch it down, as at Z, to within 1in. of the bottom of the frame; make the bottom part a little rounded, round the ends for handles, and have some leather muffs made to slip over the ends in such a manner that they will readily take off or on with laces, in order to hold a piece of lead between the handle and muff, hereafter to be explained. The next requisites will be a good shovel, and also a sieve of about 1-32" mesh.

The Sand.

The London ironfounders' sand is too close for the work, and as there are different opinions about this, I cannot do better than give Mr. Graham's advice. Take common washed Thames sand, which is generally pretty sharp, and mix with it a little loam, so that it shall bind a very little. I believe in the Highgate sand, because that which I used in my brass foundry at King's Cross Patent Valve Works was of a fine loamy texture; but as this is a matter of experience more than anything else, I shall leave it for the plumber to do as best he can, especially as sand is different in all quarters. Ironfounders say the sand about London is very indifferent. It should be, as I have said before, very sharp, with a little loam to bind it; very fine; be sifted through a sieve of 1-32 mesh, and made sufficiently damp to cause it to bind into a ball. It must also be wetted according to the substance of the lead required. If too wet, the lead won't run; it breaks. If too dry, it won't bind; it breaks up and won't enamel, and will be rough on the sand side. Next sift or spread not more than one inch thick of it over the bed of the frame with the strike and with the muffs off. After this with the bottom edge of the strike and across the frame, begin at the foot of the the bed and beat the sand down as firm and even as you possibly can all the way up the frame. Then, after the beating is completed, which is a two-handed job, the sand must be skiffed; that is, again begin at the foot of the frame, and, with the strike, strike, or rather rub, the sand backwards and forwards as though you were spreading butter on bread with a two-handled knife. This brings the sand perfectly level with the shafts. After this is done take the smoothing plane [V, Fig. 12] and thoroughly smooth the sand until it has a face as true as a line and as smooth as enamel. This is called enamelling, planishing, planing, &c. A little "touch" on the plane improves its working. (N.B.—The planes should be worked hot by dipping them into the pot occasionally). Let the sand finish at the foot very sharp, so that the excess lead shall leave the sheet instantly and allow it to contract without breaking. Next, to prepare the strike, let it be cleaned from the sand and "touch" the bottom part all over. The muffs are off and must be put on. If you want 7lb. lead, fix a piece of 4lb. lead under or between the leather muffs and strike. This will raise up the bottom of the strike sufficient to give 7lb. For 6lb. use 3lb. Some plumbers make it a rule to use the packing or lead only 2lbs. lighter than that required, but the first-named thickness is my experience in the matter. This very much depends upon the lead, if lively or not. If too hot, it will run too freely and break the mould or sand; if too cool, it won't move. In fact, this much depends upon the day; also the kind of lead, the state of the sand, and the help you get, and is only to be properly done by *experience* and *practice*. Don't for one moment think that it is easily acquired. A cold, dull day, with wind blowing up the frame, is against you. A too hot day is as bad, as it kills you to keep your strength up, and the sand dries too quickly. The fine day is the casting weather, especially for thin sheets. You must have your heat according to this. I need not say that, if too hot, the lead will run into the foot-pan without the aid of the strike or notice to yourself. The heat is acquired by experience and the aid of the testing-stick, a piece of deal wood 15in. long 2in. square, pushed into the lead, and worked about occasionally. Taking it out, which is done by holding it at an angle of about 45; if the lead just sticks or adheres to it, it is just right. Remember the lead must be well stirred up and of one uniform heat, After it is in the head-pan, if too hot, you may stir it with cold plumbers' irons. Be careful and have every thing in apple-pie order. When ready, fill the head-pan. If the sheet is to weigh 5 cwt. you will want about 15 cwt. of hot lead. When you think it is at a right heat tip it over, and away it goes down the mould, followed closely up with the strike, of course firmly pressed on the shafts. The two men must keep *equal* pace and not let the lead get behind the strike to get back lead. All the surplus lead then runs into the foot-pan, and then into the coach.

"THE LEAD'S JUST RIGHT."—"TIP"—it is going down the frame, you after it with the strike, leaving nothing behind but just the required thickness for your sheet; the surplus is in the foot-pan, into the coach; run the coach to the pot, bale back this surplus before set; all's well and all

eyes anxiously looking upon the sheet. It being the first, it's a good one; then as quickly as possible rip or trim off the selvages—that is, the rough parts off the sides and ends—roll it up, and it is ready for work. The table or frame has to be again made up, and so on, again sifting the sand every time, and clearing the steam holes in the bed of the frame, after which make up your mould for another sheet; remember you have to get off from five to six sheets a day for good work. A crane will be necessary for this amount of work.

If by chance you cannot get the surplus lead away from your sheet just before it contracts, divide the sheet from the surplus mass by drawing a knife across the same.

N.B. If the bottom of the sheet is not formed in such a manner that the surplus melted lead can get away (that is to say, with the sand left as sharp as possible), the sheet on contracting will break right across and fair in two halves. It is a good plan to fix a lath a little higher than the sand between the shafts; then the bottom edge of the sand will come up sharp. In lieu of this the lead must be whipped off with a sharp drawing knife, which will prevent fracture. A lead-worker is no use at this work unless he can run 3lb. lead when required. Mr. Graham showed me 2lb. lead which he had run lately, and it was as smooth on both sides as milled lead. Of course this is extraordinarily thin for cast lead, and requires much practice.

Lead Sash Weight Casting.

Fig. 13 shows a box for casting lead sash weights. It is simply a box about 3ft. long, 8in. square at the top and 9in. square at the bottom, and bound round with hoop iron.

FIG. 13

FIG. 14.

Neither top nor bottom is required for this box. Two handles are useful for lifting the box when filled with sand. Sounding leads for ships are also cast in boxes like this.

PATTERNS FOR LEAD SASH WEIGHTS.—[Fig. 14.] Suppose you want a weight 2ft. long by 3in. by 2in.; all that is wanted is a wood pattern made 1ft. longer than this size. The pattern should have a little taper, say $\frac{1}{4}$in. in 3ft. The end for the cord should be 6in., tapering up the two flat sides as shown. The pattern should be marked off to the length of the required casting as shown with a *line* all round.

THE CASTING.—Take the ordinary sand, as before described, and half fill the box as it stands small end up. Then in the centre of the sand fix the pattern so that the parting or guage *line* comes just level with the top of the box. Ram the sand hard round the pattern, and fill up the box with sand, and strike it level with the top. Just tap the pattern and if all is right you can gently withdraw it. If the sand is too dry it will fill up the mould again; if too wet it will stick to the pattern and splutter about when the lead is poured in, which must be done slowly. After the lead is poured let it cool (taking care to fill up as it shrinks); when the box is lifted the sand and weight will fall out. Trim and weigh; also punch a round hole in the thin or tapering end for the sash cord. This is best done with a piece of $\frac{1}{4}$in. or $\frac{3}{8}$in. gas pipe while the weight is hot. The weights should be smooth and solid. Round weights are cast in the same way and also in the flasks.

Lead Casting in Flasks.

It is not at all uncommon in large country shops for the lead worker to cast lead in all sorts of shapes, such as lift weights, ornaments, blocks, tail pieces, lugs, old-fashioned astragals, &c., which can only be done in flasks. It is the practice in London to send such work to the brass founder's, because the London plumber as a rule cannot do it, or has not the facility for doing it, although very simple work. This is one reason why I prefer the country plumber if *he is a proficient workman.*

THE FLASK.—Fig 15 is a box, in two halves, with dowels A,A,A,A; in lieu of which eight pieces of wood will answer, if nailed on the two ends and sides so that the top part can be lifted off and on without disturbing the patterns. There are four handles as at B B, for lifting apart, &c. The handles should be fixed so that you can lift the top with the fingers, the two thumbs pressing the

FIG. 15.

bottom flask. This is all that is wanted, excepting sometimes two boards, the exact size of top and bottom; but these are not often required. At Fig. 16 the flask is shown closed and ready for pouring. Fig. 17 represents the boxes empty, showing the fillet D for the purpose of

FIG. 16.

keeping the sand from slipping out. Supposing that you have everything ready, with some very loamy sand inclined to clay, put the top board on the flask and fill up the top flask, *i.e.*, the one with the pegs on (of course bottom upwards), then strike the sand level with the pegs and flask. Next bed the pattern just half-way into the sand, or in such a manner that it will easily leave the sand. Then with a very small trowel, or other handy tool, such

as a small limp putty knife, pen or pocket knife, fill up the space all round the pattern with sand. Next get some very fine pounded *soft* dry *red* brick dust and tie it up in a

FIG. 17.

canvas bag. Shake the bag all over the smooth surface of the sand in the top flask (this is called "parting" sand). Put on the bottom flask and *sift* some sand over the pattern, and fill up the bottom flask, well ramming the sand down quite hard. After this put a board over the sand and flask, and turn the flask over. Then lift off the top flask and the sand will part if sufficient parting sand has been used. The top flask must not be snatched off, but taken off very steadily, tapping it here and there round the sides, which loosens the sand around the pattern. If your sand will not bind sufficiently to be lifted up, work a lath or two across the flask. Having taken the top flask off, make the sand good round the sides of the pattern with the knife, or other tool. Now you know that the sand is solid *under the pattern*. Put some more parting sand on again, and on the top flask; then sift some more fine sand over pattern, well ram the sand with a tinman's mallet into the top flask, especially round the fillet D, Fig. 17; tread it down as hard as you can. Now, with a long turn-pin make the pouring-hole E, Fig. 16, which touches the pattern. Make also the air hole G. Strike the sand level with the sides of the flask, tap the sides gently all round in order to loose the pattern, then lift the top flask off. *Clear out* the bottom of the pouring-hole with a small penknife, and with a sharp bradawl pick the pattern out of the sand in bottom flask. Then make up the edges if at all broken, *i.e.*, round where the pattern was embedded. See that no loose sand is on the face of the mould, or that anything looks wrong; then lift on the top mould and fix the board so that it will keep the sand from floating. It is a good plan to weight it down. Next get the metal and pour, but do not make it too hot. Don't forget to make two pouring holes, one for the exit of the air, which should be at the highest point. It is quite as well to let the work dry, if time will allow, before putting the flasks together. After you have run the metal you can break up the mould and take out the castings before it gets too cold, and by dipping it into water the sand will leave it quite bright. (N.B.—The sand must not be too wet, only just so that it will bind in a ball, hence the reason for it being loamy).

Plumbobs and Moulds.—[Fig. 18.]

These are cast in soft brick, Bath, or other soft stone moulds, which are made in two halves, having a piece of copper wire through the centre for forming the string-hole. After running the lead the plumbob is taken out of the mould hot, and the wire drawn out with main force. Plaster moulds are made. I always cast my plumbobs in small flasks, three or four together. I have a dozen in one mould when casting for shops. I use wood patterns on a rod of iron. The proper method of striking a plumbob is shown at Fig. 18. Draw a right line A B 2 in. long; open the compasses and from the point C draw a half circle to cut line at A B; then put the one point of the compasses on the point A and open compasses to B and strike line B D. Then strike the line E A from the point B.

FIG. 18.

Lead-headed Nails.

Fig. 19 is a lead-headed nail; it is made by dipping the head A into a ladle full of nearly setting lead. The nail is dipped in three or four times running, until you get sufficient lead to cling to the head. If you want them very round, keep turning the nail round, and in different directions, when the metal is hot. They are used to nail on hip ridges, flashings, and round sinks, &c. By dipping the nail and suddenly raising it the under side is made cone shaped, but if you dip it into nearly cold lead and turn it round, then suddenly raise it to a horizontal position at the same time keep it on the turn, the head will be *flatter*. See Parr & Phillips' patent for same.

FIG. 19.

Window Lead.

The mould for casting the calmes in is shown at Fig. 20. It is about 12in. long, 4in. wide, by 2in. thick, *i.e.*, each side 1in., with grooves nearly the shape of the window lead. This mould has a handle for closing it. The lead is poured in, well hot, at the end opposite the hinge. It works best, as all other moulds do, when well heated.

Window Lead Machines and Turning Window Lead.

Fig. 21 is an elevation of the old glazier's vice, which I have ground away at when a boy for weeks together. A A are the frames; B B B, axles; C C, the two cutting wheels with milled edges 1½in. diameter, and the same thickness as the glass to be used. The wheels are fitted upon the axles so as to work in between two case-hardened cheeks D D. The wheels should not exceed 1-10th of an inch apart from each other. The spindles are connected by the cogwheels E E.

A smaller machine is shown at Fig. 22; it is made by Messrs. Sharratt & Newth. This illustration gives a view of the lead passing the machine; also a good view of the cheeks, but does not show the cutters or wheels, which are, however, exactly as in the old machine at A, B, C and E, Fig. 21.

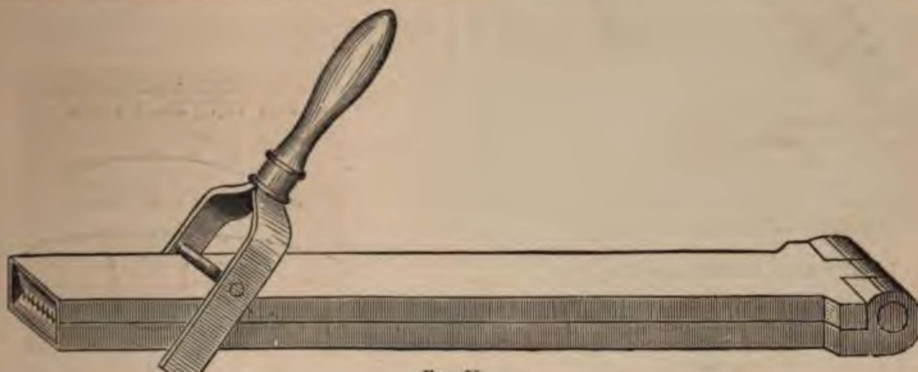


FIG. 20.

Window Lead.

Fig. 23 gives the shapes of the different sized calmes. The top row shows them in section. The one on the extreme left is for bands, which is as good as cut through with the cutter; all that is wanted is just to start it with a knife and rip it apart. This pattern is also used for fret-

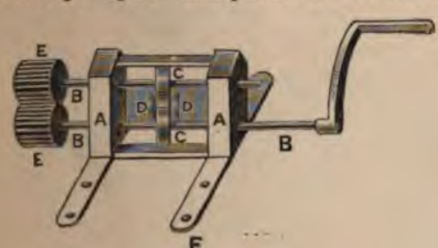


FIG. 21.

work. Of course the cutters are not fitted quite so close together if fretwork lead is wanted. The general lead is that given at the second and third figures from extreme left.

Having cast sufficient calmes, part and trim them. Take a good sharp knife and cut the one end flat (called "pointing"); then take a little linseed or other oil in between the cutters and turn the handle—not too fast, however, or the wheels get hot and will not work. Too much oil is also

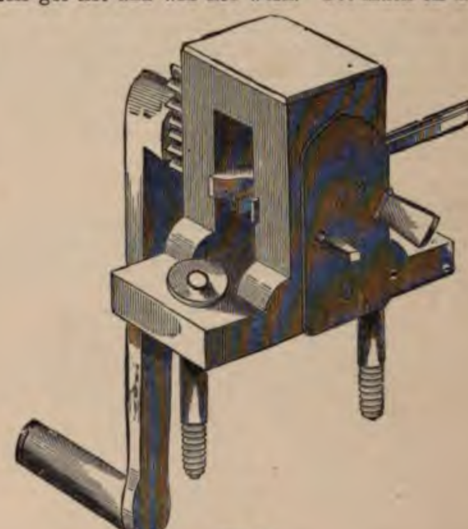


FIG. 22.

FIG. 23.

finger and thumb and rub over the lead—*not too much;* then put the sharpened end of the calme in between the against it. If your vice is in good order you will have a splendid calme of lead, which must be kept in a long box,

say 6ft. long, with partitions for the different sizes, and an air-tight lid. The box is quite as well if *painted black*, as the light should be kept away from the calmes.

N.B.—Sometimes "calme" is spelt "came," as in the United States, and in Nuttall's Dictionary, and in some parts of England, "carm."

Window lead is sometimes pressed; but it cannot be made so fine and light. It is stout and clumsy, and in working it breaks more glass than it is worth. In fact, it is of no use alongside of vice lead for working. [For a continuation of this, see Lead Light Glazing.]

Lead Pump Barrel Casting.

The barrel is cast in a mould something like the old original pipe-mould, the mandrel being pulled out by a crane or other means. This mandrel should have little or no taper, which, of course, makes it very difficult to draw. The spout or nozzle is also cast as the barrel. The head is cast in a square mould, having a core in the centre; sometimes the front side is made loose. The head should be cast with a hole for the barrel to come through, and also a hole in the front for the spout. Sometimes the barrel has beads, or mouldings, or astragals, cast on. More will be said hereafter on lead pumps when we come to make them up. Care must be taken to have sufficient taper for the sucker-box. [For making up pumps, see my work on Pump-Work, Water Supply, Hot Water and Gas Fitting, &c.]

Lead Clacks.

These clacks are cast in a two-sided mould [see Figs. 24, 25, 26]. C is the clack; *rivet* is the part which holds the clack upon the leather. The method of casting these clacks

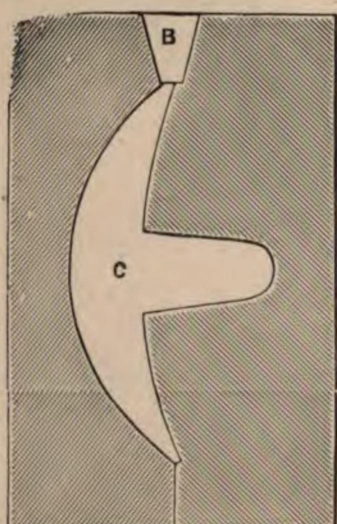


Fig. 24.

will be readily seen by reference to Fig. 24. E and E are the two sides of the clack mould placed together, having a clack cast therein. To cast this clack, make the mould hot, and place the sides as shown. Pour in the lead, and as soon as it is set turn the clack out, and fill up the mould again and again, until you have the required quantity. Having shown you the clack mould, I will explain another method of casting the lead clack when you have no mould. Have a pattern made of wood to the shape and size required, with a piece of wood nailed on to form a rivet. Press the pattern rivet-side downwards into some sand, and fill it up with lead. Here you get a good clack, with flat top, instead of rounded [as shown at Fig. 24]. These clacks are the best for

Fig. 25.

drawing the sucker, as will be hereafter explained. Fig. 25 is a full-sized elevation of the clack cast in the mould, Fig. 24.

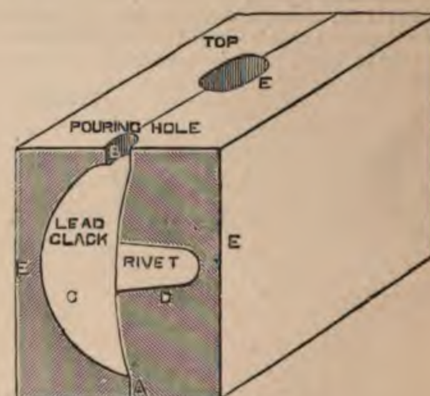


Fig. 26.

Lead Pipe Moulds.

There is scarcely any reason in this age for the plumber to provide lead-pipe moulds, draw benches, etc., as lead-pipe casting is nearly done away with; although many will be interested, and all should know how we used to make our lead pipes, especially if cast upon our beam-ends, abroad or otherwise. Moulds are made of various shapes; the first in England was invented by Robert Brocke about 1539, and very much used by Peter Morice, the London Bridge Waterworks engineer, 1582. Some slight improvements were made in lead-pipe casting in the year 1620, for the New River Company's engineer (or rather the promoter of the New River Company), Mr. Myddelton, afterwards Sir Hugh Myddelton. The Brock mould for casting lead pipes is made in two halves, from 1ft. 6in. to 3ft. in length, having a *mandrel* or "core," as it is called, inside for the lead to run round, and placed in such a manner that the same can be easily withdrawn. This core should be a little tapering, about 1-16 of an inch in the foot, and then a very slight tap on the end with the *slacker* (a mallet or hammer), suffices to slack it. The ends of the mandrel always project through the ends of the mould about 2in. The mandrel receives the tap, or slacking blow, with the slacker before the mould is opened. The mould should be made well hot, about equal to boiling water, and then placed in a perpendicular position, when the lead is poured. This casts pipes in short lengths only. After the cast-

ing is over, the short pieces are burned together in a separate jointing mould. The inside of this mould is in the shape of an ellipse. Joints for pipes are ellipses, just long enough to hold the ends of the two pieces of pipe, the short length having another smaller mandrel placed inside, and long enough to enter 6in. into the longest end. The short mould is then shut up, which grips the two ends of the pipe; then sprinkle a little resin, and pour the lead *red-hot* into the mould and on the two ends of the pipe, and the two pieces of pipe become united. The greatest care should be taken to properly clean the ends of the pipe, and well "touch" them inside and out before running the lead.

The French Pipe Mould.

This is only the joint mould made long enough to make the joint and a piece of pipe at one time, as follows: The mould is similar to that already described, the difference being that it is used horizontally instead of upright, and as quickly as possible, which gives continuous lengths of pipe. The way to get the first ladleful of red hot lead, is to place the ladle in the fire, and dip the lead whilst in this state. The stand-up pouring burrs must not be cut off unless they are afterwards soldered up, or they will leak, owing to the contraction of the lead, which leaves a small hole in the centre.

This kind of lead pipe making I worked at as late as the year 1862, although pressed pipe was then much in vogue.

Drawbench or Frame

(Fayolle's drawbench, also known as Wilkinson's Patent Pipe Frame).—The drawbench is shown at Figs. 27 and 28. This machine is exactly similar in shape, etc., to the wire drawbench, and also the bench for making zinc tubes for bell-wires, etc. It came into general use about 1800. With this table or frame originated the term "lengths" of pipe, because it can only draw a length of pipe the length of the frame. A length of pipe $\frac{1}{2}$in., $\frac{3}{4}$in., and 1in. is now known to be 15ft. long; and $1\frac{1}{4}$in., $1\frac{1}{2}$in., and 2in., is 12ft. long. Other larger sizes are made in 10ft. lengths. This term is used to this day. Four lengths make one "coil." The lead is cast in moulds as in Brock's process, but much stouter; in fact, about eight times the thickness of Brock's pipe. The mandrel or "treblet," which is of steel and tapering, is required to be longer than Brock's, and instead of pouring the lead in an upright position, it is poured with the mould placed obliquely, and the lead is poured in at the bottom, so that it travels up-hill. This is the most curious part of the work to the non-professional lead worker; but if the lead-worker runs his lead in hot moulds, and in this manner, he will never

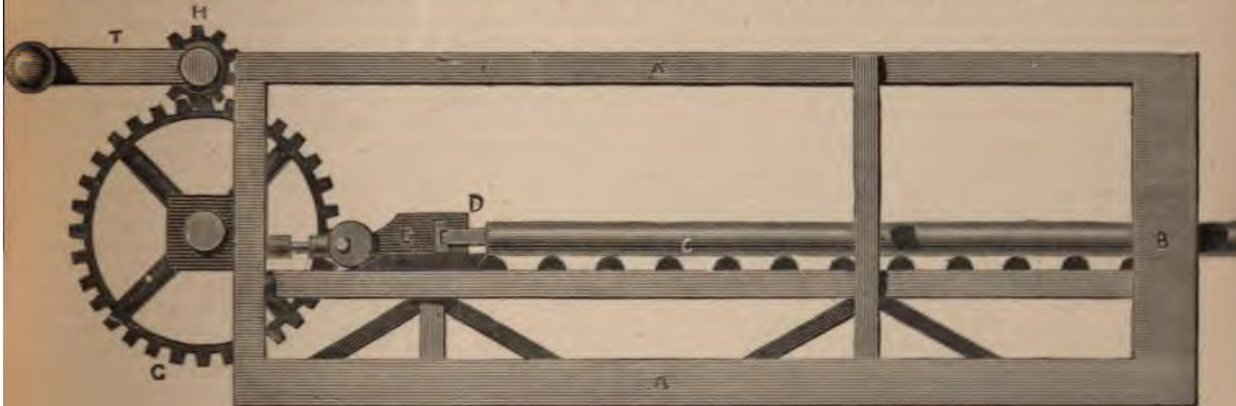


FIG. 27.

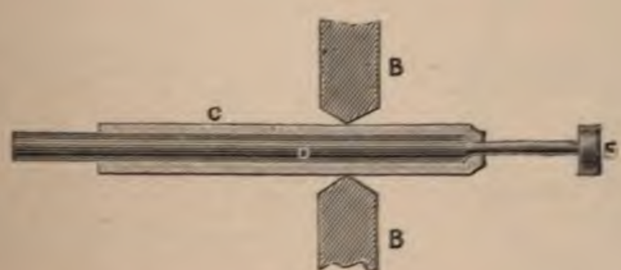


FIG. 28.

with a core which could not be knocked out, but has to be drawn out with a winch and chain. Make the core and mould well hot, and when the pipe is to be cast, the lead is poured in at the one end, called the "casting end." You can also pour in at the other end, or, as is often the case, two men can pour at the same time. As soon as the pipe is cast, the mandrel should be drawn out before the lead shrinks too tightly round it (of course the mandrel must be well "touched"); the pipe should then be taken out of the mould whilst hot, and again placed in the casting end, say 3in.; then place the small end of the mandrel into the same, and lay the other part of the mandrel into the mould. Shut up the mould close, with the hasps which hold it firmly together, and pour the first ladleful, *red-hot*, into the casting end, and fill up the mould

get spongy, sometimes called "rotten," broken, or crystallized lead. The "dies," or as they are called in the west of England, "whirtles," B B, Fig. 28, are made of steel, perforated and tapering, of various sizes. They are fixed in a beam or holder at the foot, or sometimes a little way up the bench, in such a manner that they can easily be taken in and out. Of course they must be fixed very firmly. On the small end of the mandrel D should be formed a small hook-head—[see Figs. 27 and 28], (exactly the shape of the headed pin which forms part of a swivel) to enable the slit-hook E [Fig. 27] to catch hold of the mandrel F. The lead is then drawn with compound power, crab gearing, or otherwise, through a No. 1 whirtle; then through Nos. 2, 3, 4, 5, 6, and 7, until the required substance is obtained, occasionally annealing it if required. At Fig. 27 the motive force is gained by a cog-wheel and pinion G H, turned by the wince T. The dies are shown in section at Fig. 28. Sometimes wheels are used instead of whirtles. These resemble three pulley-wheels working together, so as to form a die. They do the work much more easily, but not nearly so well. Good drawn pipes should be of an equal thickness throughout, and free from any scratches or marks whatever, and have the usual toughness of lead.

The Lead-Pipe Press.

This is an improvement upon all the before-recited methods. It is adapted to make pipes to any gauge, length, and quality. The Pipe Press has undergone many alterations, but the first principle is still in use. Fig. 29 is a sectional elevation of the original Pipe Press of Bramah. I cannot do better than refer my readers to the old and

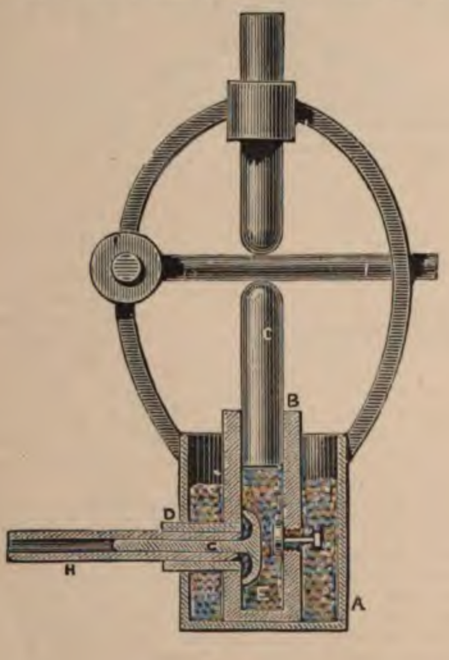


FIG. 29.

original specification of Bramah's patent of 1797. I shall also refer my readers to the original specification of Thomas Burr, Hague, Ellis and Burr, Hanson and Hanson, John Rand, Newton, Gardiner, Weem, and others, so that if they should get with any strange press they will not be lost. We will take Bramah, who, in his written specification of 1797, describes a machine, as he says, showing a new method of making tubes of lead or other soft metal of all dimensions, and of any given length whatever, without joints. This is performed by a process of pumping or forcing lead, &c., in its liquid state, through metal moulds, by which tubes of any given shape or size may be made with great expedition and perfect accuracy. He forms a kind of pot [A, Fig. 29], in the centre of which is fixed a cylinder of iron, B, with a piston, C, fitted into it. When the latter is pressed down with considerable force it impels the lead through an aperture or die, D, fixed in the side of the pump and pot. This die is equal in size to the outside dimensions of the tube intended to be made. In the end of the mould tube or die next to the pot and pump is fixed a cross or bridge, E, into the *centre of which is fixed a mandrel*, G, or cylindrical bar of iron or steel, turned perfectly true, and of the diameter equal to the inside or bore of the pipe, H, to be made. The die or mould and the cylindrical bar must be in a small degree diminishing in diameter toward the external end, which extremity must terminate with the end of the mould or thereabout. Of course there must be sufficient opening in the cross or bridge and the die to allow the lead to flow. At I is shown a portion of the lever by which the piston is forced down. In this way any length or size of pipe can be made perfectly sound and without a single joint.

Burr's Pipe Press.

About twenty-three years after Bramah came Mr. Thomas Burr, who claimed the right of making pipes of lead or other suitable metal by pressing it or forcing the metal in a *solid state* through an aperture of the form required; not by drawing or *rolling it*, as is the present practice. He says that his machinery for making pipes consists of a strong iron cylinder or barrel, true with parallel sides, for a piston to work in, open at one end, and closed at the other end, except a hole being left in the centre to admit the pipe to pass through. Into this hole is fixed a washer or thimble, the hole through which is the exact size of the outside of the pipe intended to be made. The washer is made to take out and in, to allow of being replaced by others. A strong piston is made to fit the inside of the cylinder, and in the end of this piston which enters the cylinder is fixed perpendicularly a round core or rod, the length of the cylinder and the diameter of the inside of the pipe intended to be made. This rod or core is made to take off and on to admit another, and it may be of any size. It must be large enough to hold sufficient lead to make one length of pipe. If it is 6in. diameter, and 1ft. long, it will require to be at least 4in. thick. The manner of using this apparatus is as follows: The cylinder is fixed perpendicularly, with the end uppermost to which the washer is fixed; the piston is drawn down until it is nearly out of the cylinder. The upper end of the core or rod will then appear through the centre of the hole in this washer; if it should vary it must be wedged in the centre. Clean melted lead is then poured into the cylinder, by the space between the core and the washer, until it is full. After it has stood until the lead is set the piston is forced into the cylinder which presses out the lead through the aperture between the core and the washer in the form of a pipe. When the piston has pressed out all the lead the pipe is sawn off above the core or rod. The piston is drawn down again to its former place (viz., nearly out of the cylinder). A short piece of pipe will then remain, so as to stop up the passage or space between the core and the die or washer. To clear this passage melted lead, heated nearly to a low red, is poured on to the pipe remaining, which soon melts it away, and the lead must be continued pouring until the cylinder is full as before. To take the

melted lead into the cylinder a small hole is sometimes employed, which is stopped up when not in use. The method used to force the piston into the cylinder and to draw it back again is as follows: The cylinder is fixed (by a flange cast thereon for that purpose) in a perpendicular hole through the centre of the top of the frame of a powerful hydraulic press in such a manner that the upper end appears above the frame of the press. For the purpose of access to pour metal the press is made to heave upwards and to pull back again. The piston is fastened to the heaving-rod of the press by a screw, so that it can be easily taken off to clear away the lead that may hang on when the core or rod is to be changed. The cylinder should be warmed before beginning to use it, after it has stood from working, by making a small fire round it. This dries it, and makes it work the easier. The foregoing are Burr's own words.

Other Varieties of Pipe Press for Tinning Pipes, &c.

Next comes Hague in 1822. He fixes his press horizontally, and, instead of a hydraulic press, he applies a powerful screw, driven by compound cog-wheels. He claims nothing, although the first to work pipes in this manner.

Ellis and Burr, in 1836, obtained a patent for tinning the pipe as it is made, this being done by enlarging the top part of the die, so as to form a metal pot to hold melted tin, which coats the *exterior* of the pipe, as it is forced upwards through the die, and the inside is coated by pouring melted tin into the top of it as soon as it rises above the mandrel.

The tin is kept hot by a fire round the pot. Pipes were tinned inside in the year 1804.

Hanson and Hanson, in the year 1837, followed up Ellis in his improvement. Instead of the long mandrel which was placed or fixed at the bottom of the piston or plunger of the hydraulic press, this mandrel is rigidly fixed to a bridge-piece inside the cylinder of the press, and concentric with the die opening, its lower end protruding through it. It is the same principle as Bramah used, and which is used in the best presses. Some lead workers say you cannot get good pipe pressed in this way. Those who say so know nothing about it, as I have proved both ways. All Mr. Clarke's presses are made in this way, and who can make better pipes?

John Rand obtained a patent in 1843 to make lead pipe from thick, short tubular rings of lead, which, when put under a powerful plunger, fitted accurately in a cylindrical chamber having dies in the bottom, as in Burr's patent. He produced lead pipe without injury to the die or other working parts of the apparatus resulting from the heat of the molten metal. This was very little used. Of course, lead pipe made in this way was too hard.

Then, in 1845, Mr. Newton, a patent agent, received a communication from abroad, and took out a patent to tin the inside of lead pipe as follows: The fixed mandrel (as in Bramah's and Hanson's patents) for the purpose of this invention is made hollow, whence lateral passages open into an external annular recess. The cavity in the mandrel being in communication with a chamber attached to the apparatus containing the molten tin, before the newly-formed pipe is forced off the end of the mandrel, it passes over the annular recess into which the tin continues to flow through the internal passages, and being brought into contact with the internal surface of the pipe it attaches itself thereto, forming a coating the thickness of which is regulated by the size of the end of the mandrel which smoothes the surface of the tin as the lead pipe is forced off. Of course the parts of the machine which contain the tin must be carefully kept up to the degree of heat necessary to preserve the tin in a state of fusion, but not too much heat.

The best and cheapest method of tinning lead pipe (only it tins it inside and out) is to pass it through a bath of tin, the tin being kept about 100° below the fusing point of lead. I always tin my lead in this way. *(If you want them done properly, do them yourself!)*

G. Perry Gardiner, in the year 1851, made pipes of lead in such a manner that during the process of making the fibre or grain was laid crosswise instead of longitudinally. The lead was placed in a die chamber (as in Hague's patent), which, whilst the metal is being forced or drawn out through the annular opening between the die and the end of the core mandrel, is caused to revolve. This motion of the die has the effect of laying the grain or fibre of the metal transverse to the axis of the pipe, working and drawing round and round. In this way, pipes of greater strength are produced, and the pressure required to force the metal through the die caused to revolve during the process is considerably reduced. This process is not much used; it is suitable for the Canadian water pipe. It has a very pretty appearance.

John Weem, in 1852, made a press with the ram and shaping die solid or in one piece, for making lead pipe of *large sizes*. He makes use of the hydraulic press. This press has two pistons, the internal one fixed, the other movable. On the movable piston is a receiver for the lead; the outside of this receiver, or rather, the external part of the inside, forms the outside or die for forming the outside of the pipe. On the inside piston, at the upper end, is fixed a kind of bell, the inside of which is fitted truly to the inside part of the receiver for the lead, formed upon the top of the movable piston. On filling the receiver with lead, and giving an upward motion to the movable piston, it carries with it the lead. Then the lip of the cup (fixed on the internal piston) being stationary, comes in contact with the lead, and on sufficient force being applied to the movable piston causes the lead to be squirted, or squeezed, up between the external part of the inside of the lead receiver and the external part of the fixed cup. In this system there is no necessity for the whole area of the ram to come in contact with the lead; this reduces the amount of pressure to the least possible fraction required for the work. This press looks ungainly, but works exceedingly well, no doubt; it is the best for large pipes.

In 1853, Edward K. Davis made an apparatus to force lead through dies without a plunger. He applied compressed air. He also claims to be the inventor of casing soft metal pipe with block tin; also plating of sheets, which was done by Dodd in 1804, and Burr and Ellis. He also claims coating pipes with indiarubber. Of the latter he may have been the inventor. It is useful in frosty weather.

John Anthony and William T. Chafe's press is for manufacturing lead pipe in quantities, they not being satisfied by making one at a time. Their invention consists in combining two or more dies, either separately or in the same plates, with core bars fitted to each. Of course their dies receive their supply from the same cylinder or metal reservoir as Bramah's, Burr's, &c.

Charles Felix Seville's invention to line the internal part of lead pipe with tin is much about the same as that conceived by Mr. Newton, the difference being that the mandrel (which is hollow) is filled when the stump or short end of the pipe is about 6in. above the die. This system is not so good as that conceived by Mr. Newton. Seville also claims tinning lead pipes as they exude through the die, the tinning bath, &c. In fact, there is nothing new in this invention, as the bath was known in the days of the old draw-bench, and Newton's process forestalls Seville thirteen years.

Mr. Clark, of Hammersmith, has just completed a patent for pressing lead-pipe. He has two containers, which are *worked by one piston*. The containers are made to revolve in

such a manner that he can fill one whilst the other is being pressed. He claims the advantage of the men being at work during the time the lead is solidifying, or rather, to use his own words, his men are busily engaged pressing a charge whilst another is cooling. The men, who evidently thoroughly understood their work, pressed one charge whilst I examined it, and the operation only occupied them 4½ minutes. Though only 4½ minutes, this going on continually is a great saving. The pipe was properly worked, and everything in first-class style, and I consider that Mr. Clark's new press is the best save one which I have seen. I should here remark that I was surprised to see the great improvement in this firm since I last examined it in 1867. Mr. Clark himself showed me over £3,000 worth of pig-lead which he had obtained from dross, &c. Of course he has on these works reverberatory furnaces, rolling-mills, four or five presses, and the best machinery I ever saw in a lead works.

Other Uses of the Press.

After giving the particulars of the pipe press, I may here remark that the same apparatus is employed to make square and other shaped pipes; and also solid rods of lead for cartridges, lead wire, and for forming differently-shaped astragals, window-bands, and the bars for making the calmes and many other purposes.

The Author's own Press.

[*See* Fig. 30, page 37.]

I cannot pass on without giving my reader a view of the simple and very effective press invented by myself. The drawing requires but very little explanation. Fig. 30 shows Davies' "Improved Lead Pipe Press." The pipe A is connected to a powerful pump, say 2½ tons to the square inch. This pipe conveys water into the water cylinder B, and forces the piston C down into the cylinder for lead D, when the lead becomes compressed and is squirted out at the bottom between the die E and the mandrel G in the shape of lead pipe H. The die can be easily removed for a smaller or larger one, or for any other kind of die. When the lead is all pressed out, the water is pumped out of the water cylinder and the piston rises. A small pipe is also fitted between the cup-leathers, L L, which supplies water to the top cup-leather, and which forces the ram upwards into the cylinder B. Then fill the lead cylinder and again press out. This lead cylinder is kept hot by steam and condensed water from the boiler which passes round it at I I, and is also one of my improvements. It also quickly solidifies the lead, so that no time is lost in waiting before pressing the charge. The pipes as they are pressed are rolled up round a drum in 60ft. coils or bundles.

At K K are the flanges for fixing; L L L L are leather cups; M M the cheeks or lugs of the press, withstanding a strain of 300 tons, which is at times put on this press; and at N is shown a plan of the mandrel taken at X. This press can be made to work either way up. [For Lead presses to press up bent lead pipe, such as soil-pipe bends and ᔕ-traps, see Fig. 193.]

Table of Lengths, Weight, and Working Strength of Lead Pipe.

Lead pipe, as all other materials, varies according to the quality, for instance a hard, tenacious metal will, weight for weight, stand a greater pressure to the square inch than a soft one, and on this account there is no reliable theory whereby the actual strength of lead pipes may be determined. This table is taken from actual experience, and not worked out theoretically. For pump work, and for pipes having valves closing suddenly, the weights should be half as much again to the lengths of pipe, so as to allow for the regurgitation.

The length of a coil or bundle of lead pipe for ¼in., ⅜in., ½in., ¾in., and 1in. pipes is 60ft. Sometimes 1¼in. pipe runs 60ft., but this is too heavy a bundle. The coil or bundle of 1¼in., 1½in., 1¾in., and 2in. pipes is 36 feet long. Other or larger sizes are made in lengths only, for which see below:—

15 FEET LENGTHS.

Diameter of Bore in Inches.	Weight of Length of 15 Feet.	Safe for a Column of Water, in Feet.
¼″	20 lbs.	600 Feet.
⅜″	15 ,,	50 ,,
,,	20 ,,	250 ,,
,,	25 ,,	500 ,,
½″	14 ,,	50 ,,
,,	18 ,,	100 ,,
,,	20 ,,	200 ,,
,,	22 ,,	300 ,,
,,	25 ,,	400 ,,
,,	28 ,,	500 ,,
,,	30 ,,	600 ,,
⅝″	18 ,,	100 ,,
,,	22 ,,	200 ,,
,,	30 ,,	500 ,,
¾″	22 ,,	40 ,,
,,	24 ,,	80 ,,
,,	26 ,,	100 ,,
,,	28 ,,	150 ,,
,,	32 ,,	250 ,,
,,	36 ,,	350 ,,
,,	42 ,,	500 ,,
,,	45 ,,	600 ,,
1″	30 ,,	30 ,,
,,	36 ,,	60 ,,
,,	42 ,,	100 ,,
,,	48 ,,	200 ,,
,,	56 ,,	305 ,,
,,	60 ,,	400 ,,
,,	64 ,,	450 ,,
		(will stand 500).

12 FEET LENGTHS.

Diameter of Bore in Inches.	Weight of Length of 12 Feet.	Safe for a Column of Water in Feet.
1¼″	36 lbs.	25 Feet.
,,	42 ,,	60 ,,
,,	48 ,,	120 ,,
,,	52 ,,	250 ,,
,,	60 ,,	500 ,,
1½″	36 ,,	20 ,,
,,	48 ,,	50 ,,
,,	5 ,,	100 ,,
,,	72 ,,	250 ,,
,,	84 ,,	400 ,,
,,	96 ,,	550 ,,
1¾″	72 ,,	100 ,,
		(not recommended).
,,	84 ,,	200 ,,
,,	96 ,,	300 ,,
2″	36 ,,	15 ,,
		(will stand 25).
,,	56 ,,	50 ,,
,,	64 ,,	80 ,,
,,	72 ,,	100 ,,
,,	84 ,,	200 ,,
,,	96 ,,	300 ,,
,,	112 ,,	400 ,,
,,	120 ,,	500 ,,

Diameter of Bore in Inches.	Weights in Lengths of 10 Feet in Lbs.								
2½″	36	70	84	96	112	130			(The 5 last are for pumps).
3″	42	60	80	100	112	120	130	140	(From 60 for pumps).
3½″	56	90	112	120	130	150	160	180	(From 112 for pumps).
4″	56	70	80	112	140	150	170	200	(From 140 for pumps).
4½″	60	84	112	140	170	200	220		(From 140 for pumps).
5″	170	200	234	254	280				(All for pump work).
6″	300 (For pumps).								

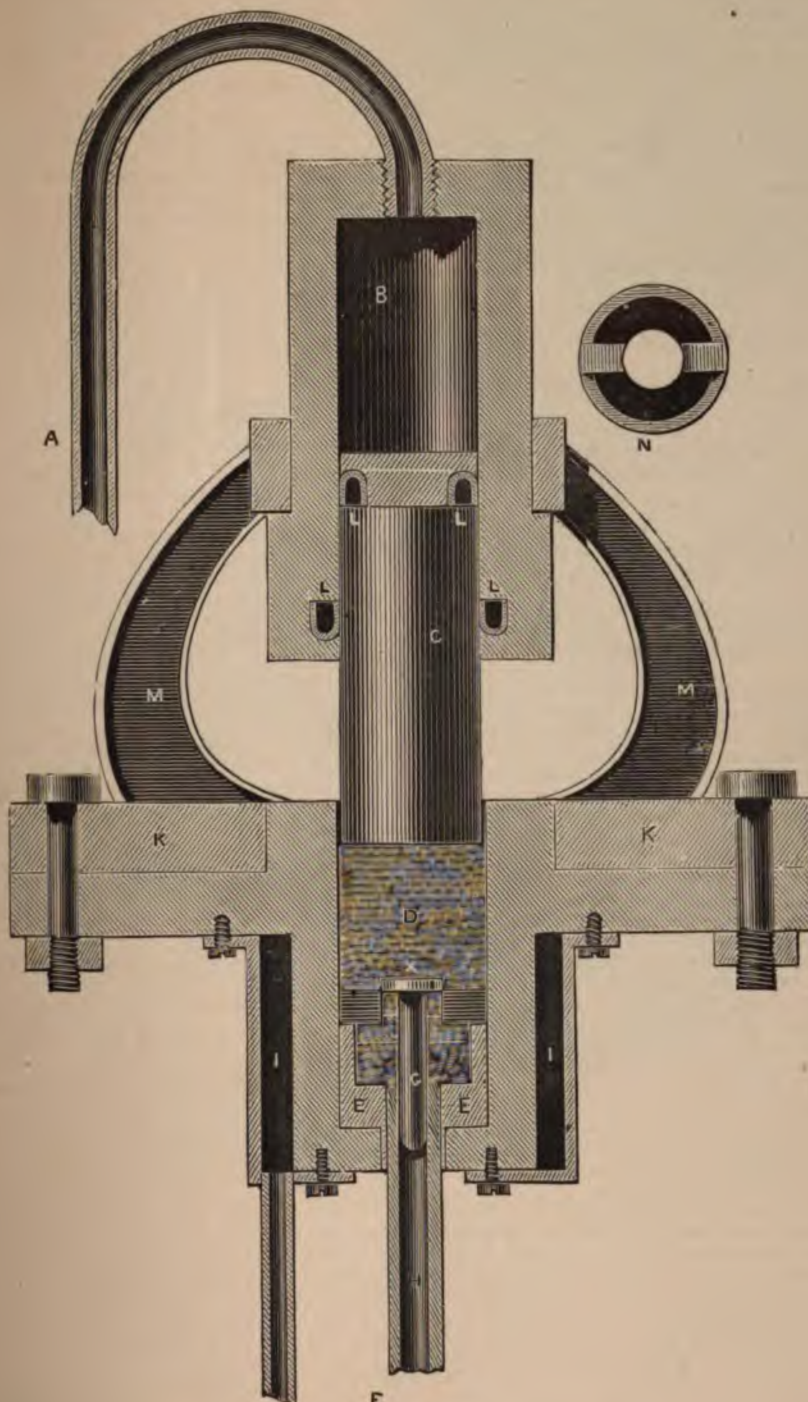


FIG. 30.

P. J. DAVIES' IMPROVED LEAD-PIPE PRESS.

Soil Pipes are pressed from 5 to 10lbs. to the foot super., and to the following sizes, in 10ft. lengths. If hand-made the pipes are much more even, and may be made in lengths to suit the job, which is a considerable advantage sometimes. They should always be burnt up or drawn, *not copper bitted*, as the solder is too fine to stand.

10 FEET LENGTH.

Bore	2½″	3″	3½″	4″	4½″	5″	6″

Weight of Composition or Gas Tube Per Yard.

Size	⅛in.,	3-16in.,	¼in.,	5-16in.,	⅜in.,	7-16in.,	½in.,	⅝in.,	¾in.,	1in.
Weight in oz.	5¾	7½	11½	13¾	17	23½	27	37	46	48.

Weight of Tin Pipe for Filters, &c. Per Yard.

Size	⅛in.,	3-16in.,	⅜in.,	7-16n.,	½in.,	⅝in.,	¾in.,	⅞in.	1in.
Weight in oz.	7	9	11	14	17	23	30	38	48.

Our next will be sheet-lead rolling mills, as follows:—

The History of the Rolling Mill.

This machine was invented in the year 1670. The following is a copy of the original patent, so that there can be no mistake about the date, as plumbers think mills are of very recent invention:—

"A.D. 1687. . . . . . No. 254.
"Engine or Rollers for drawing Lead into Sheets.
"Howard and Watson's Patent.

"JAMES THE SECOND, by the Grace of God, King of England, Scotland, France, and Ireland, Defender of the Faith, &c To All to whome these P'sents shall come, greeting.

"WHEREAS wee are informed that Sir Philip Howard, Knight, Deceased, and Francis Watson, Esquire (now Sir Francis Watson, Knight), having found out A New Manufacture, Art, or Invention, By a certain Engin, or Rollers, to Draw, Roll, or Mill Plates or Sheets of Ledd, by them Cast or Prepared for that Purpose, did at the Sessions of Parliament holden at Westminster, in the two and twentieth yeare of the reigne of our dearest brother King Charles the Second of blessed memory, obteine an Act of Parliament for the Sale, Vse, and exercise of the said Invencon, for the Sheathing and Preservacon of Shipps and Shipping onely, to continue for five and twenty yeares. . . And whereas wee are likewise informed that the right and tytle to the said worke or invention an Act of Parliament is come to the hands of Richard Knight, Esquire, Charles Davenant, Doctor of Laws, Thomas Agar, Esquire, John Warter, Thomas Hale, and Michael Hale, Gentlemen, who haveing humbly represented vnto us that since the passing of the said Act they doe finde the said manufacture, worke, or invencon of mill'd lead may be of good vse for many other purposes as well as sheathing of shipps, and having by their humble peticon besought vs to grant to them the sole vse and exercise of the said invencon for the purposes aforesaid for the term of fourteen yeares, wee are graciously pleased to condescend to their humble suite.

"KNOW YEE THEREFORE, that wee being willing to Cherish and Promote all laudable endeavours and designes of such our subjects as have by their industry found out Usefull and Profitable arts, Misteries, and invencons, and to the end that the said Richard Knight, Charles Davenant, Thomas Agar, John Warter, Thomas Hale, and Michael Hale may reape some fruit from their labour and charge in and concerning the p'misses, of our speciall grace, certaine knowledge, and meere mocon, have given and granted and by these P'sents doe give and grant vnto (the above) speciall lycence, Power, Privilege, and authority. [Then this goes on to say that the above persons shall put into practice as follows.] At theire or some of theire owne proper cost and charges, erect, vse, teach, exercise, and put into practice the said manufacture, art, or invencon soe contrived and found out as aforesaid as well for sheathing of shipps as for any other vse or purpose whatsoever.

"AND FURTHER, wee doe by these Presents for vs give and grant vnto (the above-named) full Power and authority, haveing first obtained a warrant in that behalfe with assistance of constable or other lawfull officer as well within liberties as without dureing convenient times in the day, and in lawfull manner shall make search in any place in the said Kingdom of England and Wales, where there shall be iust cause of suspition of persons imitating or vseing this invencon, and the workes found may be seized vpon, broken in pieces, defaced, and spoyled, and the materials left in the hands of some constable to be disposed of in such manner as shall be directed."

This patent met with great opposition from the plumbers. Dobs in 1804 rolls lead with hot rolls.

Afterwards comes Burr in 1839 and claims rolling lead with rollers heated with hot water, or otherwise; then in the same patent he says, *all which, however, is well known to engineers in heating rollers for other purposes.*

Operation of Milling Lead.

The lead to be milled is first melted and cast in an iron pan or mould, about 7ft. long by from 5 to 6 ft. wide and from 5 to 6 in. in thickness, according to what substance may be required when finished. It is then passed between the rollers (or, as it is termed, through the mill to break it down). This causes it to spread very much in length, say to 30ft. long. It is then cut into halves and the two lengths together again several times passed (of course backwards and forwards) through the mill, when the rollers (sometimes called cylinders) are brought down, or together, a little every time the sheet passes the cylinders (the sheets should not be allowed to run out or there will be the trouble of pinching them between cylinders with the starting bar. After the sheets are milled they are rolled up, weighed, and stamped, the number, length, thickness, in pounds, per square foot, and the weight, as follows: Suppose a sheet to be 34ft. long by say 7ft. wide, 5lbs. lead. This should be marked as follows:—

Sheet of Lead
Length 34
No. 728.
5, 10, 2, 14

But this sheet which is taken from one which I have just cut up was marked thus:—

Sheet of Lead
34
728
5,11,0, 18

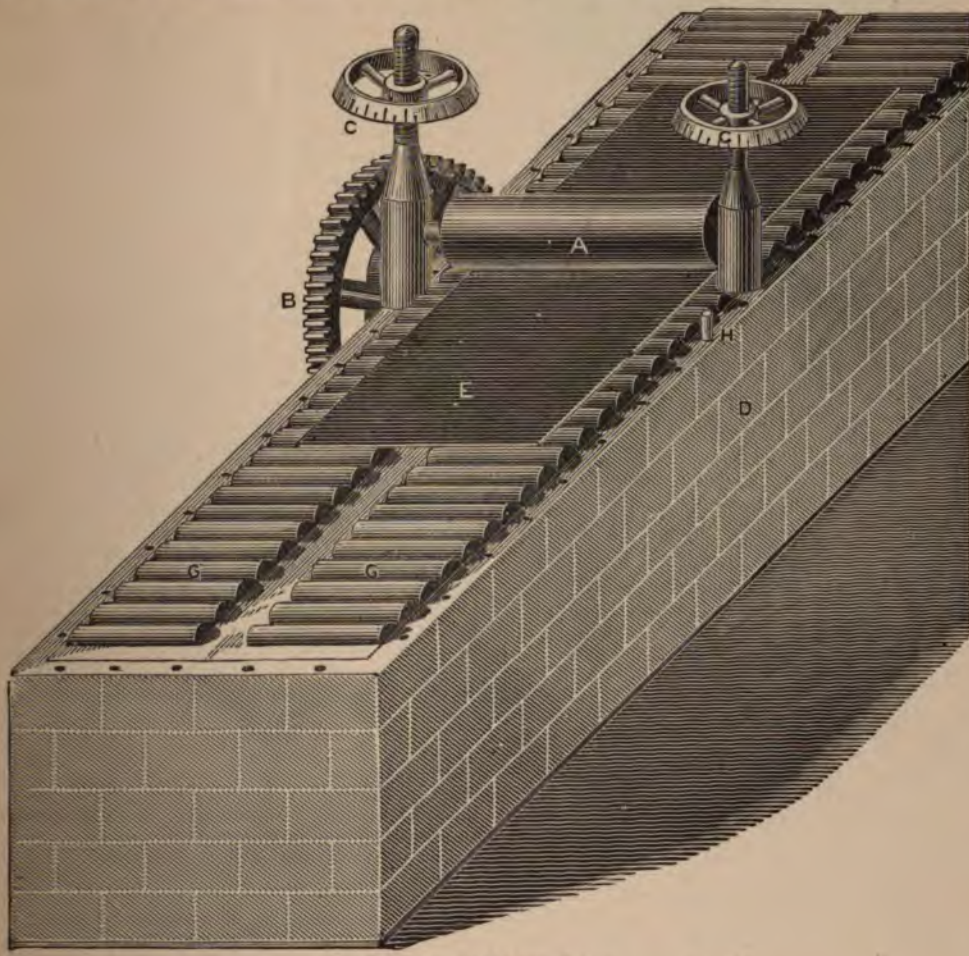
Of course I need not say that this irregularity is owing to the milling and the difference of the density of the lead; there is no mill in the world which can alter this. This is what deceives the plumber, lead-worker, builder, and architect in estimating lead work by measurement instead of going by what is proper and just—the weights only. I give this simply to show that lead-work cannot be measured to tally with the weight, especially after it is laid. The millman, as a rule, makes his lead heavier than the same is stamped. I have often cut up 5¼ and 5½ lbs. lead which has been stamped and sold for 5lbs. As a hint to millmen, keep your weights according to your stamping; plumbers take

this into consideration, and you will be patronized if your weight does not per lineal measurement *exceed* that which it should be. The same applies to the pressman when his dies become worn. Good milled lead should be of equal thickness, soft and without drags, blisters, scales, and not too greasy. But, in general, sheets of lead are thick at the ends.

Thickness of Sheet Lead.

The following is the thickness of sheet lead to the square foot, near enough for all practical purposes (but all lead is not the same weight, bulk for bulk, which sadly puzzles the builders:—

Say	A cubic foot of lead equals	709 lbs.
and	A square foot, 1″ thick	59 ,,
	12″ square by 2-15th	8 ,,
	$\frac{1}{8}$th (which some lead-workers say is 7lbs. lead) ...	$7\frac{1}{2}$,,
	1-10th	6 ,,
	1-12th	5 ,,
	1-15th	4 ,,
	1-20th	3 ,,



LEAD-ROLLING MILL. Fig. 31.

These measurements cannot be taken properly with the rule or callipers, but require an instrument equal to the well-known Whitworth measuring machine. Sheet lead is sometimes made as thin as writing paper, called laminated lead. It is much used to cover damp walls before painting.

The Rolling-Mill.

I have described the old tool for making sheet lead and will proceed to describe the present in as concise a manner as possible. The rolling-mill [see Fig. 31] for the manufacture of sheet lead is a very costly apparatus, not only in itself, but in the machinery for driving the same; therefore, it is not to be seen in many plumbers' workshops. In fact, it is rarely to be seen at all, as many who possess this article appear to be under the delusion that another such mill cannot possibly be found. Nearly every owner thinks he has the best or some peculiar secret part about it, and is by no means particular in telling you so. I have examined a great many, and have had a lot to do with lead mills. If there is to be any choice, give me the mill at Mr. Clark's, at Hammersmith. This mill will turn out a sheet of lead 35ft. long by 8ft. wide, but mills are now to

be found milling sheets 9ft. wide. The width is of great importance to the chemical works' plumber when making chambers, or to the builders' plumber when laying flats; it enables the lead worker to put down wider bays than he can with the 7ft. sheets, and it also enables him to cut the sheets to an advantage. The mill itself is simply a pair of truly turned iron or steel rollers [as at A, Fig. 31], the longer the better, but the general length is from 7ft. to 9ft. and from 12in. to 24in. in diameter. Some of these rollers are kept hot with water or steam passing through their centres. The rollers are brought together and opened by means of the standard regulating screw gear [see C C Fig. 31], which will adjust the rollers to the thousandth part of an inch. These rollers are fixed in the centre of the bed of the mill; this bed should be at least 70ft. long and must be provided with a number of, say, 3in. friction rollers (which are about half the length of the width of the bed and butt end to end), for carrying the sheet backwards and forwards as it passes through the mill. At the sides of the beds are holes for dropping a pin [H Fig. 31] into for the purpose of forming a fulcrum for the crowbar, called a starting bar (a bar having a claw to grip the lead), and sometimes at the end of the bed is found a winding apparatus for rolling up the sheets after milling. In illustration, A is the upper roller, B cog driving-wheel, C regulating gear, D brickwork, E sheet of lead, G friction rollers, and H fulcrum pin.

Having described the various methods of casting, pressing, and milling lead, we will next see about making up solder, as without the solder many of the plumbers could not very well manage.

TIN AND ITS MANIPULATION.

Before proceeding to make solder you should know something about the materials of which it is composed. I have explained sufficient about the baser metal, lead, and will now proceed to explain the principal metal, tin.

TIN (Anciently called Jupiter).

Symbol, Sn (stannum); equivalent, 58·82; specific gravity, 7·292.

Although this metal has been known probably as long as any, the ores of tin occur in but few localities. It is not found in its metallic state, and its only ore of importance is the deutoxide or tin stone, which occurs crystallized in prisms isomorphous with those of titanic acid.

This ore is usually found in veins running through the primitive rocks of porphyry, granite, or clay slate, and, as a rule, it is mingled with the sulphides and arsenides of copper and iron, and also with wolfram.

The Cornish tin mines were celebrated before the Roman invasion; an idea of the richness of these mines may be conceived from the fact that at least 4,000 tons of tin are furnished by these mines annually. Tin stone is also met with in Malacca and Borneo and Mexico.

The Cornish mines almost invariably run east and west. Tin ore is also found in alluvial soils, carried there by the action of water. When it is found here it is known as stream-tin. The ore occurs in detached rounded masses, and is very pure. The position of the veins is often traced by following the stream towards its source, up to the point where the ore ceases to be found; and if done carefully a vein of ore is almost certain to be discovered. The tin lodes are nearly perpendicular, and are sometimes worked to a very great depth, as much as 2,000 feet, but the tin floors are of a lesser depth, and have nearly a horizontal strata. In the old mines of St. John, in Penrith, are found very ancient tin floors, where the mineral appears to have been lodged in bunches or masses shaped something like a kidney. When the tin ore is brought out of a mine it is known as "spaller," and is placed in heaps of different qualities, according to its appearance.

Having found the ore the metal must be extracted, and, therefore, the ore must be subjected to a series of operations something like the ore of lead. Some of these operations are mechanical, whilst others are of a chemical character. The first is the picking of the purer portions of the ore by hand; the other passes to the stamping mill, something like a pestle and mortar, where it is reduced to a coarse powder about ¼in. square. This powder is then buddled and washed to mechanically remove the lighter impurities. Sometimes the stamping mill is supplied with a stream of water which continually washes the ore onward through a sieve having meshes of sufficient fineness. The ore passes on into large cisterns, about 18ft. long, 9in. deep, and say 20in. wide, having an inclination of ¾in. to the foot, and so arranged that as one fills the other is being emptied after the mechanically suspended mineral matter has been carried off by the water.

The mineral matter carried off by the water is allowed to deposit in slime-pits to be again treated.

I should say that the best ore stops at the head of the cistern, whilst the poorer runs onward towards the foot or lowest division, and which is called "tailings." The head ore is now carried by the stream to a square cistern; this head ore is now passed to the tossing tub, which is like an ordinary hooped tub; it is here stirred up with a shovel and thoroughly washed with water, allowed to settle, and the water drawn off, and the powdered mineral is found to be in different layers, of which the best is at the bottom. The workman can take out each layer separately from the other, and, if clean enough, the ore is ready for the roasting processes.

Roasting.

Having stamped and washed the ore, there are still some impurities left in the material, such as arsenical iron and copper pyrites, and the next job is to get rid of these substances. The ore is now to be placed in a reverberatory furnace, with or without charcoal to expel the sulphur or arsenic; the ore now becomes converted into a yellowish brown powder, which operation takes from ten to twelve hours to complete.

During this roasting the ore should be occasionally stirred to expose fresh surfaces freely to the air, and by this exposition of fresh surfaces the iron pyrites is decomposed and is converted into sulphurous acid and peroxide of iron. The arsenic is in like manner also expelled as arsenious acid, whilst the greater part of the sulphide of copper is converted into sulphate of copper, and this conversion will be completed by exposing the mass in a moistened state to the air for a week or so.

Next, this ore must be washed, viz., the sulphate of copper is then dissolved out by lixiviation; after which the principal part of the peroxide of iron, as it is much lighter than the oxide of tin.

Smelting, or Reduction of Tin.

In order to obtain this object, the ore is mixed with from about $\frac{1}{4}$ to $\frac{1}{8}$ by weight of powdered anthracite, or charcoal, small coal, &c., and a little lime or fluor spar to facilitate the fusion of the siliceous gangue which still remains mixed with the ore. Make the mixture just damp enough to prevent the powdered or dust part from being carried away by the current of air. Now throw it into a reverberatory furnace having a low crown. The charge being upon the hearth, the heat must be gradually raised for five or six hours, when the oxide of tin becomes by the carbon reduced, before the heat is sufficient to cause the oxide to fuse with the silica, with which it would form an enamel which would be difficult to reduce. Now raise the heat until it becomes very intense, to render the slags fluid; the reduced metal now subsides to the bottom, and is now run off into pans, and ladled out into moulds, which will have to undergo another turn of melting known as liquation, refining, &c.

Liquation or Refining Tin.

The ingots of tin are now heated to incipient fusion upon the bed of the reverberatory furnace, and require great care. The furnace must not be too hot, but just sufficient to melt the rich or purer part of the tin out of the block; the purer tin being the more fusible portion, it generally melts or sweats away from the block, and leaves a honey-combed alloy which has a higher melting point. This less fusible portion of the tin, when remelted, is the ordinary block tin. The best tin is now drawn off into a second pan in which the metal is gently heated, and kept in this state for some time, during which time the metal is subjected to the action of "billeting." This is simply done by pushing a few green or dampish sticks into the tin so as to cause it to bubble up; the decomposition and the escape of steam and gas from the wood causes the melted tin to enter into a state of violent ebullition, and as the gases rise through the molten tin so they bring up all the slag, dust, dirt, and other mechanical impurities to the surface.

After this treatment has been continued for a matter of three hours, the metal is skimmed off and allowed to stand for a matter of two hours; it is then again skimmed clean, allowed to settle, which it will into three stratas, which are carefully ladled and cast into ingots ready for the market.

The purest and best metal will be taken from off the top part of the pan, and is put on one side; of course this purity is owing to its density not being so great as that of the metal below, and its tendency to separate from its alloy.

The finest quality of the metal is frequently heated a second time to a temperature a little short of its melting point; at this temperature it becomes brittle, and if allowed to fall from a height it will break into irregular prismatic fragments, which are known as dropped or grain tin.

The splitting of the mass into these fragments is somewhat of a guarantee of the purity of the tin, for impure tin does not become brittle in this manner.

Pure Tin.

Should the tin be required perfectly pure the metal can be obtained by means of voltaic action. A concentrated solution of crude tin in hydrochloric acid is put into a beaker, and water cautiously put in without stirring up the dense solution below. Place a bar of tin into the solution; here beautiful prismatic crystals of pure tin are gradually deposited on the bar at the point of the junction between the metallic solution and the water.

Properties of Tin.

Tin is a white coloured metal resembling that of silver, but with a soft tinge of yellow, and has a high metallic lustre. When first cut it does not lose its lustre when exposed to the air. It is sonorous though rather soft, malleable, and ductile, but possesses little tenacity. At a temperature of about 212° F. its ductility is considerable, and it may be drawn into wire, or laminated into what is known as tinfoil. When bent it emits a peculiar creaking sound, and if the bending is continued backwards and forwards it becomes sensibly hot at the point of flexure. This phenomenon of the heat depends upon the mechanical alteration of the relative position of its molecules, and their mutual friction. It when handled gives a peculiar odour to the hands. It is a tolerably good conductor of heat and electricity; its fusing point lies between 428° and 442° F.; it is not sensibly volatilised, but will boil at about 3,103° F., and if heated much past this heat it will take fire and become rapidly oxidized and burn with a brilliant white flame, and a white powder of stannic oxide (sometimes called putty powder) is formed.

Nitric acid attracts tin very sensibly, and produces an insoluble hydrated binoxide of the metal, nitrous fumes being given off, and stannic oxide being left as a white powder. At the same time, owing to the decomposition of water, a quantity of ammonia is formed, which enters into combination with the excess of the acid.

Strong hydrochloric acid dissolves tin with a solution of hydrogen and the formation of stannous chloride. Dilute sulphuric acid is without action on the metal, but if the concentrated acid be boiled upon it the tin becomes converted into sulphate, while sulphurous acid escapes.

Tin Monoxide Sn O.

This is a black powder which may be prepared by heating the stannous hydrate with carbonic acid; it rapidly absorbs oxygen from the air, passing into stannic oxide. The hydrate is precipitated as a white powder when a solution of stannous salts is added to an alkaline carbonate.

Sulphides of tin, stannous sulphide, S Sn S, and stannic sulphide, Sn S_2, are the most important. The Sn S is a blackish grey, and the latter, Sn S_2, a bright yellow crystalline powder soluble in alkaline sulphides.

METALS AND ALLOYS.

Fusing Points of Metals and Alloys.

	Melts.
Iron (cast)—The pot will melt at white heat	2,912 Fahr.
Copper—Pipes and *Bits*, bright red, from 1,800 to	2,000 ,,
Silver—Taps for Filter, Pipes, &c.... ...	1,832 ,,
Brass and Gun metal...	1,650 ,,
Antimony—Red heat for the expanding metal	810 ,,
Zinc—In Brass bosses, &c.; beware of the Solder	773 Fahr.
Mercury ... ... boils	662 ,,
Lead—If the metal is too hot it tells a tale	612 ,,
Lead boils and evaporates at white heat	
Bismuth—For very fine solder	500 ,,
Tin—Melts at	428 ,,
Begins to spoil past this heat; forms Putty Powder—boils at	3,092 ,,
Water boils	212 ,,

Solder-making Table and Fusing Points.

As the melting-point of lead is 612°, or about, according to the class of lead, so we must have our solder to melt at a lower temperature, and as the solder very much depends upon the nature and quality of both the lead and tin, no correct rule can be laid down, as you may have a sluggish lead or a lively lead —in fact, one of our standard works differs in its own columns on the melting point of plumbers' solder. Yet, no doubt, it is recorded correctly. In one place it lays down the rule as follows :—1 of tin, 2 of lead, melting point, 441° Fahr. On the very next page it says plumbers' solder, 1 of tin and 2 of lead, melting point 475°, 34° different—of course by the same scale. I contend that this difference was caused by the use of dull or lively lead or tin.

Davies' Solder Table.

I have worked out the following list of different fusible alloys or solders which may be used by plumbers :

Names. &c.	Lead.	Tin.	Bismuth.	Mercury.	Cadmium.	Melting Pt.
	20	1	"	"	"	550° Fah. or about.
	10	1	"	"	"	5[illegible]0 "
	5	1	"	"	"	510 "
Coarse	3	1	"	"	"	480 "
Plumbers'	2	1	"	"	"	440 "
Fine	1	1	Less than tin alone		"	370 "
For tin pipe	1	1½	"	"	"	330 "
	1	2	Notice this ; more tin, increase of heat required to melt.			340 "
	1	3	"	"	"	350 "
	1	4	"	"	"	360 "
	1	5	"	"	"	375 "
	1	6	"	"	"	380 "
	4	4	1	"	"	330 "
Called Pewterers'.	3	3	1	"	"	315 "
	2	2	1	"	"	290 "
	1	1	1	"	"	250 "
	2	1	2	Beware of hot water.	"	234 "
	5	3	8	0	0	212 "
	1	1	2	0	0	201 "
	3	5	3	0	0	200 "
	3	2	5	0	0	199 "
	1	0	4	½	0	185 "
	6	0	7	0	1	180 "
	3	2	5	1	0	167 "
	4	2	7-8	0	1-2	150 "
	3	5	3	3	0	122 "

Solder, Analysis of.

A.—Weigh one grain of solder, which must be cut into small pieces. Next mix or treat it with equal parts of strong nitric acid and water; then very carefully heat the lot over a sand bath until the liquid is evaporated to dryness; now add more water, boil and filter it, wash it; then ignite filter and contents, weigh and calculate into metallic tin as follows :—

SnO_2 Sn

150 : 118 : : weight found : X = Metallic tin.

B.—Filter from A and evaporate to a small bulk; now let it cool, after which mix the solution with sulphuric acid in slight excess, and add to the mixture twice its volume of alcohol; next allow it to settle, and filter it, then wash its precipitate in alcohol. Next dry it and detach it from the paper into a porcelain crucible, add filter ash, ignite and weigh it; then calculate it into lead as follows :—

$PbSO_4$ Pb

303 : 207 : : weight found : X = Metallic lead.

Expanding Metal for Plugs, &c.

The following metal expands on cooling :

Lead	9 parts.
Antimony	2 "
Bismuth	1 "

It is the antimony which expands, but this alone is of no use for general purposes.

Tenacity of Lead (to increase).

12 parts lead, 1 zinc.

The tenacity of zinc is here doubled, and the alloy has six times the tenacity of lead.

Hardening Lead.

To harden lead use zinc or tin.

Mixing Lead and Zinc.

To mix lead with zinc use arsenic.

Decomposing Lead and Zinc.

Heat the alloy to white heat, when the zinc will be volatilized and the lead remains.

SOLDER.

History.

The history of solder will be interesting to many, especially when we know that the Chinese have records of its use as early as 2200 B.C. They assert that Yu, who was about this date semi-king, with his partner Chum, caused bronze vases to be made, some of which were cast, and others made in pieces of copper joined with different soft metals, which, however, were not so lasting as the former. This is fully 4,080 years ago. Besides this we have very good authority for the ancient use of solder by the Egyptians, who were undoubtedly A1 plumbers. They were not satisfied with simply laying lead and pipes. Imbricated vases of lead were the delight of the Egyptian plumber. We find them represented in the tombs of Thotmes the Third, and, which is still more interesting, we can trace the old Phœnicians 1000 B.C. (before Solomon's temple was thought of) and no doubt long before, fetching tin from Britain.

In Malacca, tin was found in the very remote ages. Soldering lead pipes is mentioned by Vitruvius. The ancient plumber not only knew how to do his work, but (unlike the plumbers of the present age) took advantage in soldering with the capillary action of the solder, for we read that their soldering was so neat that it could not be seen. They were in the habit of lapping the lead, and letting the solder sweat underneath, especially in cisterns, where the water was likely to eat away the tin, as they called it, and even to this day such work is done by the chemical works' plumber, under the name of sweating, when lining chambers, &c. If my readers will take the trouble to go to the British Museum, and hunt up the old works, they cannot fail to notice the wonderful wisdom and skill displayed by the ancient plumber, particularly in the science of metals

and hydraulics. See the works of Hero and Ctesibius. Witness also Jacob's well (which was no doubt known long before his time, because we are not told or informed that the patriarch had it made; he only owned the land). The well is to this day, as of old, 105ft. deep and 9ft. in diameter.

Yusset's (yes, Joseph's) well at Cairo surpasses all. First, it is sunk 165ft.; then, having a large chamber or adit at right angles at this depth, it is again worked down (out of the perpendicular line of the first shaft) 130ft. It is really two wells, one below the other, 295ft. deep. The first well has a spiral passage way for asses, &c., to go down to work the machinery. In order to appreciate the ingenuity, skill and knowledge displayed by ancient plumbers and some of more modern date, we have only to look at those wonderful machines, the pump and the hydraulic ram, also the hydraulic press and the endless contrivances and mechanical movements, to say nothing of chemistry, which the plumber has had to do with.

City Solder.

This solder is made and tested to the standard scale of 2 of lead and 1 of tin, which is tested by taking a small portion in a given sized mould, weighing it to a standard, and stamping it ready for the market.

Solder-Making, Plumbers'.

Take one cwt. of good old lead or lead cuttings (scraps of sheet lead), run it down thoroughly, stir it up, and take off all dirt or dross. Then take 56-lb. of, say, Bolitho and Sons' Penzance tin, stamped with the lamb and flag, under which is the word "Chyandour." Let this run down. Then, when it is nearly all melted down and is cooler, throw in ½-lb. *black* resin, and well stir the lot up. Fetch up the heat to about 600 degrees, or a little less, which may be known by submerging a piece of *Times* newspaper in the molten metal, and if it blazes quickly the solder is hot enough. Give it another good stir up and fill your moulds, which are prepared as follows:

For making solder on a wholesale plan get a quantity of shallow boxes like the flask box top B, Fig. 15, and some

Fig. 32.

good close binding sand; fix these boxes *perfectly* level and imbed the pattern into the sand; the sand will harden and the mould will answer for many times. The solder may be picked up or turned out of the mould without disturbing the sand. The general method adopted in ordinary plumbers' shops is as follows:

Take the ordinary sand in the sand box as before described. Then just damp the sand sufficiently so that it will bind (*not too wet*); take the solder mould (properly speaking, a pattern) [see solder mould Fig. 33], imbed same in sand perfectly level (use a level), and, with a mallet, hammer it so as to get a good impression. Take out the pattern, and should you break the sand at the sides you can make it good with the putty knife, Fig. 32, and pour mould full of solder as quickly as you can. The head of the pattern will make a runner, so that you may pour in one place near same. If your sand is too wet, or your solder too cold, you will not get that fine yellow and purple hue upon the solder called the "bloom" (the tin suffers most by the heat; it rises and oxidizes quickly), which makes it look good. If you particularly want this, get up a stronger heat, or throw into the pot a knob of brimstone; but the solder should not want this, as it is quite good enough for toning down. The colour is nothing. One way to tell good solder is to take a ladleful and pour it on a clean, dry, level stone, and if the metal has a white appearance on both sides it is too coarse and requires more tin, but if a few bright greasy-looking spots are to be seen on the underside then it is finer, but not up to the mark. If it spots here and there on the top side, say, large or ⅜in every inch or so, the solder will do. If too fine it

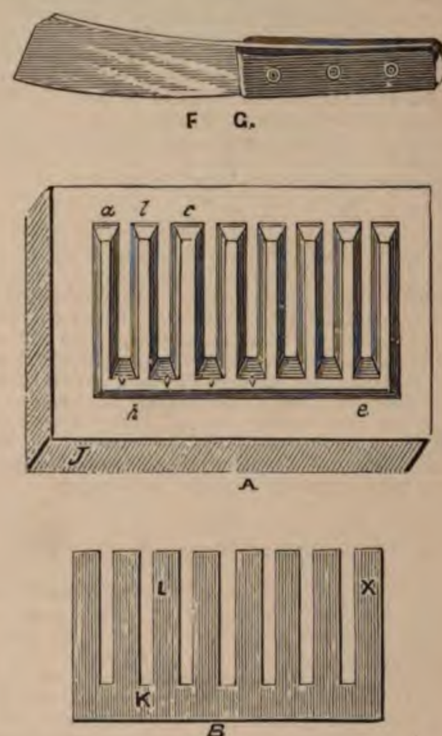


Fig. 33

will be all spots or very thick. I can tell when I have sufficient tin by "hefting" it in the ladle, which can only be acquired by *practice*.

Solder, Hards for.

It often happens that in jobbing shops the plumber will have a lot of old joints called "hards." They should be carefully cut out with a chipping-knife [Fig. 33] and small hammer, and kept for solder-making, as in this case you save tin. Care must be taken not to put them into the pot *damp*. I should here remark that lead (and everything else) must be well dried and free from damp before it is put into the pot, if the latter has molten lead or other metal in it. It is highly dangerous, owing to the sudden generation of steam (*and other causes hereafter to be spoken of, which will require particular explanation*) below the fluid metal, to put damp ladles (or, in fact, anything else) whilst damp into

molten metals. Test this solder as before with the spots. [Also see "Fining Solder."] Of course, this solder cannot be considered first-class, although it may be if the hards are good (*beware of gutter or roof "hards"—see "Bad Solder"*).

Solder, Fine.

Mix half lead and half tin, as before described [Plumbers' Solder], which makes good fine solder, melting at 370° F. [see table]. If, when held to the ear, it creaks or makes a grating sound only just perceivable, when it is bent (cold) backwards and forwards, it is fine enough. If the grating is rather loud, it is too fine, and requires a little more lead. Well stir the metal up and pour it into the iron mould before described (this is called "*Stick Solder*"), or run it out on a clean level stone into straps 12 in. long or longer, and ½ in. wide. This is called "*Strap Solder.*" This is quite a favourite way, especially with the old school of plumbers. The secret of making good solder is to keep it clean and free from dirt, dross, &c. Of course, you want the proper quantity and quality of tin and lead.

Solder, Fine Pressed.

Fine solder is sometimes pressed, like so much solid rod of lead [see "Lead Pipe Presses," "Other uses of the Press,"] Some presses, as for instance, John Anthony's press, have a lot of dies instead of one, whereby the solder can be made as fast as you like, and cut up into the required lengths. The ingredients are as above. I may add that this is not much practised, there being no better method than running the solder into moulds. J. Pullen and Sons are our largest solder makers known in England, and they use iron moulds for fine solder making.

Solder, Blowpipe.

This is made of 1 of lead and 1½ tin, as before described ["Plumbers' Solder"] and melts at 330° F. It is poured out with a ladle having ⅛in. hole drilled in the spout, on a clean slab fixed out of the level or on the slant. There are other methods of running this solder in large quantities and by which a ton of solder can be run by a man and two boys in a day; one method is by the use of a hot iron trough with a handle pulled along on a perfectly level iron plate, the trough having a number of ⅛in. holes for the lead to run through as it is pulled along the level plate. Remember that this solder melts very easily; but as I have given you a new "Solder Table," you can ever after this make your solder to suit your work. Don't forget the following list of the metals which are used by the plumber and lead-worker.

Solder, Refining.

It often happens that solder will get some foul rubbish into it, such as zinc, burnt tin, and lead, iron, &c., which causes the solder to set or crystallize contrary to the general rule. This is known by the solder quickly curdling or setting and working rough, with the tin separating and looking like so much sawdust, excepting colour, which, if disturbed when cooling, is a kind of grey-black. This is often caused by dipping brasswork into the pot for tinning, and also when soldering brasswork to lead, &c., when if too hot [see "Zinc"] the zinc leaves the copper and the tin takes it up, because the tin and zinc readily mix. A small portion of zinc will also cause the lead and tin to crystallize or separate. This requires very particular attention, *and cannot be managed otherwise.*

Solder Zincy.

If you have any idea that there is zinc in your solder (the least trace is quite sufficient), heat it to about 800°, or nearly red-hot, only just visible in the dark (if visible or red-hot in the daytime it will be *at least* 1,100° of heat, *enough to spoil any metal, and red-hot irons don't improve solder*); throw in a lump of brimstone (sulphur), which melts at 226° F., but at a greater heat between this and 430, just below plumbers' solder, it thickens, and from 480° to 600° remelts, and again becomes thinner, hence the one reason for the increase of heat. The other reason is that at 773° F. the zinc melts, and being lighter than lead or tin, has a chance to float, especially with the aid of sulphur. The gravity of lead is 11·45; tin, lighter, 7·3; and zinc. lighter still, 6·8 to 7 (just enough to rise); and sulphur, 1·98. The latter mixes with the zinc, &c., and carries the lot of foreign matter to the surface. It also brings up all the oxidized lead and tin in the form of a whitish powder called "Putty Powder," which may be in the pot, or makes it fly to the iron. This being the case, *skim the solder well,* and with the aid of tallow, after the heat is brought down to about 480°, or just below working point, stir the lot well up in plenty of tallow, which will free the sulphur, and your solder will be clean. A good lump of resin will improve it (*add a little tin*). If you have very much zinc present the best way will be to granulate the solder as follows: Just at setting-point turn it out of the pot, and break it up with the dresser like so much mould or sand; put it back into the pot, and cover it with spirits of salts; let it soak for a day or so, then well wash the lot, and serve it as above. This will effectually take the zinc out. Afterwards add a little more tin to compensate for that destroyed by the excessive heat and the acid. A little arsenic very readily carries zinc through the solder, as the one clings to the other. You see that the lead and tin can be separated by one rising above the other, therefore always stir it before you take out a ladleful for use.

Solder, Burnt.

This is often taken for zincy solder, and is generally caused by inattention. N.B. *Never stir* solder when it is red-hot, but let it cool down to about a good working heat; there will a thick scum rise on the surface which should be carefully skimmed off at working heat; often a little tin will right such metal. I do not know which is the worst, zincy solder or burnt; I think the latter, because it cannot be so easily detected. If we suppose that injury results when you make the solder red-hot, say to a visible red in the dark, 950° Fahr. (nearly 450° hotter than it should be), what must we suppose will be the consequences if you get it to a bright red, so that you can plainly see it in the daylight, which will be 1300° Fahr., or 700° above what it should be? When we consider that tin melts at 428°, and lead at 612° (or the two together at 440°); that lead rapidly becomes porous, and oxidizes at 612° (when it is known as rotten), and that tin at 428° forms putty powder, what may be expected when they are subjected to such heat? Why, all the nutriment, so to speak, or more properly speaking (if I may use the term), the binding properties, get burnt up, and it is this pliable and binding property which makes the solder work *like butter,* which ductility is always seen in good solder. This is one reason. But for the other, the metal becomes at the ordinary heat cloggy and dull; it won't move; it is

charged with the oxides of lead and tin, which will not separate from the mass; it must have some assistance to carry it up. Well, it is readily carried up with sulphur; the sulphur carried up with tallow; and the consequence will be that as the tin has suffered the most it rises in an iron grey, sometimes a little yellow, colour, and the surface of the metal will look hard, showing that there has been a separation of the lead and tin.

DAVIES' MAXIMS.

Zinc and arsenic mixed with lead,
Form the mason's mallet head;
Arsenic and sulphur's very light,
And carry zinc from solder quite.

By keeping this to gentle heat,
The work will nearly be complete;
"Touch" and resin do the rest;
The solder's now the very best.

But burning solder makes it rotten,
The day of which I've not forgotten;
Then add some sulphur to the pot,
And stir about the smoking lot.

Then some tin, 'tis understood,
Will make this solder pretty good;
After this you will take care
The proper heat is always there.

Solder, Bad.

If you have only a small quantity of solder, burned or zincy, it is best to make it up into fine solder, or use it for repairing roofs. Remember, *do not put fine solder into your plumber's solder*, unless you know what it is. Some solder will work well for about six or ten heats and then become coarse and like so much sawdust; its appearance will be black and dull; it will become very porous and unworkable without more tin. This is due to the fact that poor tin has been employed or some foreign substance, such as antimony, fouled metal having slight traces of bismuth, &c., has been mixed with it. It will form teats on the bottom of the joint, and will be difficult to keep on the work. Keep adding more tin to the solder.

Solder, Spoiling.

Some plumbers do not know how to alter their solder the right way. They will, when too fine, or when it hangs to their cloth, add more tin instead of a little lead; whilst at another time, when it is too coarse, or sets too quickly, they will add lead, and then growl because, as they say, the solder is duffing stuff. [See Joint Making.]

Solder and Zinc (Tools).

Never have zinc near your solder or melt zinc in your solder pot, or your ladle, as you cannot get rid of it afterwards without a lot of trouble. It will hang about for months.

Plumbers' Paste.

The best is that kept by the shoemaker, and purchasing this saves a lot of trouble. In default of this, however, make the paste as follows:—Take two teaspoonfuls of flour, mix it up in a *clean* ladle with cold water to the consistency of thin cream; then boil it, keeping it well stirred, until it becomes paste. Don't burn it. Burn the ladle out to clean it. A little cloves will keep the paste from stinking or turning mouldy.

SHEET LEAD CUTTING.

Unrolling and Removing Sheets.

The first thing wanted is a *good* platform of sufficient strength [for this see Fig. 38]. As we are about to

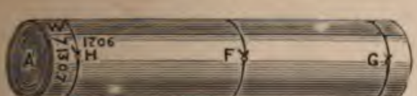


FIG. 34.

cut up sheet lead for the soil pipes, it will be quite as well to know the best and easiest way to set about it. We have, let us say, a sheet of 7lb. lead weighing 13cwt. 0qr. 7lb., quite too much for any pair of plumbers (a plumber and labourer) to move without assistance, *but it must be done;* then comes into play the assistance of the lead-worker's ingenuity and skill with levers (which are not properly understood by the greater number of good lead-workers, because in large shops the lead is often cut up for them by the shop hands, or shifted about by having plenty of strength—often one pulling against the other. This I have seen with my own men, and if you speak to them about it they think you are wanting to find fault). We must have a fine day or a dry place to unroll the sheet.

Fig. 34 is the sheet not cut. It lies against the wall, the wrong way for unrolling [see the difference in Figs. 34 and 36 at W W W, and 37 at W], that is, it cannot be unrolled without turning it end for end, which must in this case be done by two persons. (When unloading sheets always see that they are laid right for unrolling.) Take the handspike described in "Workshop and its Tools," place the narrow *bent* end in the hole A as tightly as you can (a little chalk will cause it to bite better); then at the end of the handspike, which must lean or incline a little the way you wish the sheet to go, thrust it down. If it won't move take the other handspike) and with one at each end of the sheet make it a two-handed job. It moves! Let us pull it over with our hands, which is done by placing the hand three parts over the sheet and pulling by main force. Keep it rolling as fast as you can, as it goes easier when once started—of course, owing to its momentum. When it is at a

good distance from the wall, get on the other side of it, and push it either with the hands or with the feet; the latter is the favourite way, especially when you can get sufficient help, but it wants plenty. It is far enough; let's turn it!

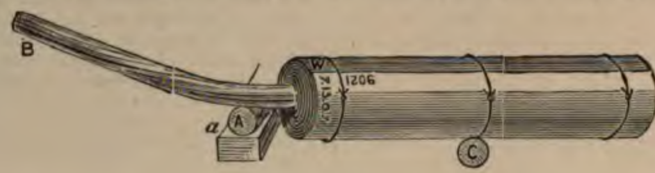


FIG. 35.

Take the small roller A [Fig. 35], place it as at A; then with the handspike B (the roller A forming a fulcrum), prize the end up—the nearer the roller to the end of the sheet the more likely you will be to raise it. The handspike thus used is called a "lever of the first order," in mechanics. It is too much for us; what shall we do? Try again, with a cross lift [Fig. 36]. Let the handspike B remain; take a brick, piece of wood, or shift the roller A to the position *b*, place the handspike D under B and on the roller A (or a piece of quartering will answer for the fulcrum A), which will give you compound leverage of the second order. The longer the leverage from the sheet to E, and the shorter the leverage from the roller (fulcrum) A

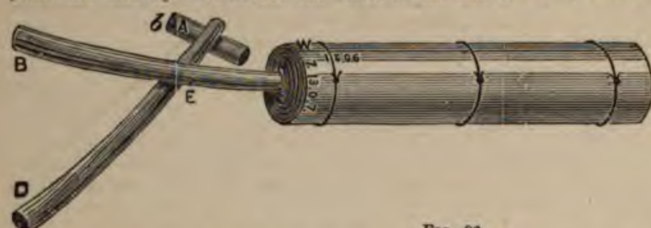


FIG. 36.

FIG. 37.

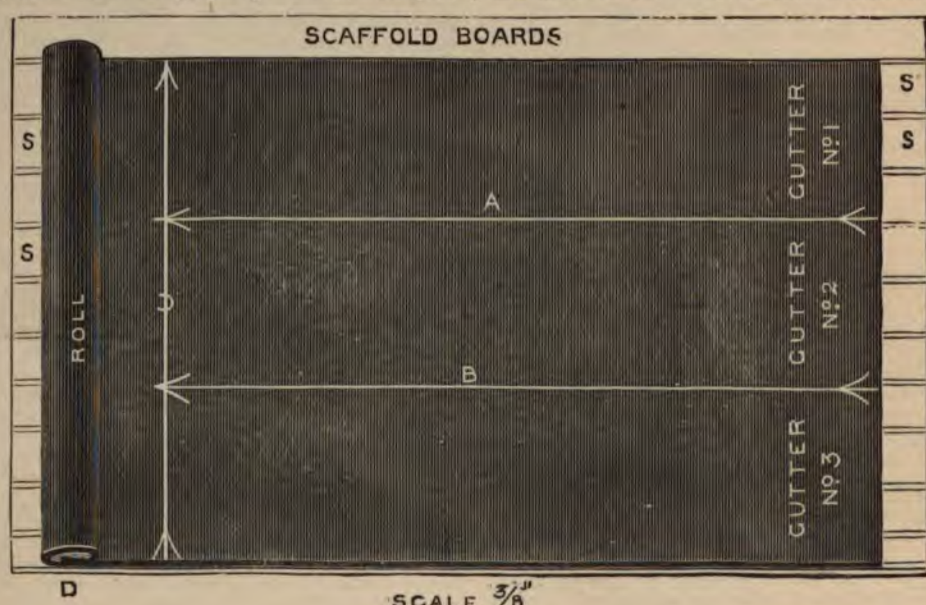


FIG. 38

to E, the more power you will obtain. Now lift the lever D—the sheet is up. Place something under the end, prising again and again until you have it sufficiently high to place the roller under, as at A, Fig. 37 (about the centre of the sheet); then with the handspike B slue or turn the sheet quarter round. Take the other roller, or cut the present one round square with the sheet, and slue again until the sheet is far enough; then with the two handspikes placed under each end of the sheet (but not too far) prise the sheet (second order of leverage) off the roller. If you wish to slue or cut the one end of the sheet a little farther round, you can do it with the levers or handspikes, as at Fig. 36, *not using the rollers or fulcrum* A, as there shown. This sheet now stands right for unrolling [see W, W, W, W].

I have not said anything as to the making of a platform, which is done as follows [see Fig. 38]:—S S S S are the eleven scaffold boards, which are just the thing; a dozen

would be better—you can always think of this number as it is equal, or, say the boards are 9in.; then 12 by 9 equals 108; the sheet 7ft., equal to 84in, leaving 24in. for the knife to drop on. The boards should be 15ft. long. The strings [H, F, G, Fig. 34] must now be cut. Now unroll the sheet, which is done by two or more stooping, and either pulling or pushing at the roll until they have undone, say, three feet. Then get on the lead and push it over either with your hands or feet. For my part, I prefer to see my men pull it over, as the foot-work appears to me rather a lazy habit.

Cutting Out.

Here a large square is handy. This can be made in five minutes of three pieces of slate-batten or the like nailed together with three nails. I like the square 3ft. or 4ft. long. It does not matter how rough, so that it is true.

Chalk Line.

A good line of a medium thickness, say about 1-12th of an inch, is indispensable to the plumber, and a rule or straight edge which is described under the heading "Cutting out Lead" (of course for roof work the chalk line is best, because the scratches may come just in an angle and cause the lead to split when working at this point).

Drawing Knife (Long Handle).

The cutting-out knife is described briefly in shop tools, "Wooden Tools," but if you refer to Fig. 39, where one of these handy tools is represented, it may give you an idea of what it is made like. A is the cutting point, which should always be kept as sharp as your pocket drawing-knife, and the point to the shape shown. From A to H is about 5in. or 6in. long, and about 1in. to 1½in. wide, top or back, 1¼in. thick, handle made out of a broomstick, &c., having a ¾in. iron or other socket, K, to keep the end from giving way. This handle is about 3ft. long. I always use a long knife, even for trimming off, where I can. The hole, D, should be ¼in. to ⅜in. and large enough for a piece of iron or copper wire or ring to work loosely through; this is for attaching the pull cord, E, to which should be attached a piece of sash-cord about 7ft. long. Having marked and snapped the lines, A, B, D, on the Sheet [38], take the knife and dip the point A into a "dip-pot," some water, or spit upon the end; then the mate takes the end of the cord, and keeping in a true line with the chalk line, with his hands as low as he conveniently can, let him pull the knife along the chalk lines, you holding same by placing your right hand at B, the left at F. Keep the handle at F down, and do not put too much pressure on, or twist the knife, but keep it upright and keep F in a line with the chalk line [see Cutting-out Soil Pipe]. It is now ready for rolling up. This is done as follows:—Having it cut as at A, B, and C, Fig. 38, take the pocket knife and cut it apart, say 3″ down the cut; next take the lead and pull it apart say 18″ down; now kneel down and form one end into a roll of, say, 3″ to 4″ diameter, and commence rolling it up, keeping the ends parallel with each other. *Keep the hole clear through the lead*, for the end of the rope to pass through when hoisting, &c.

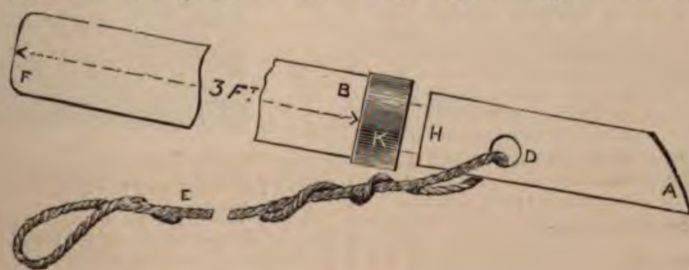


FIG. 39.

Plumber's Pocket Knife.

[Fig. 40, *Quarter Full Size.*]

This tool the plumber cannot be too particular about; it should be kept quite sharp, and its *point* as *shown*. Never strike the back of the blade with the hammer, &c., for by so doing you strain the rivet, and in a short time it will give way, and most likely hurt your hand or strain your wrist. Never put the blade near hot solder nor try to cut solder with it. Remember that this knife should only be used for lead or wood.

FIG. 40.

SOIL PIPES.

History.

Now we have the sheets of lead about, we may as well cut out a few lengths of soil pipe, which should be one of the first jobs given to the apprentice to make up.

These are of extremely ancient invention, due, perhaps, as some think, to Asiatic ingenuity. Soil pipes have also been in use in the East from almost the earliest recorded time. They were well-known in old Rome, and other ancient cities. The soil pipe was used in France before it was known in England. Sir John Harrington was a great advocate of lead soil pipes in Queen Elizabeth's reign. The very old soil pipes were wiped, then came copper-bit seams, drawn, and last (and *worst*) pressed, although to some these latter may appear the best.

Materials and Sizes of Soil Pipes.

These pipes are, as before stated, made in different ways, and of various material and sizes, from 3in. to 6in., the general sizes being 4in. and 5in. Undoubtedly, lead is the material given us for making soil pipes. It should be of

equal thickness, and from 7lb. to 10lb. to the square foot, *hand-made*, as the material is much more even—in fact, pressed pipe is, as a rule, thin on one side and thick on the other, with a lot of scratches or die-marks, especially the mandrel, or inside part of the pipe. It is a very common thing to see this pressed pipe 8lb. thick on one side and 4lb. on the other. It may look all very well at the ends, but cut it in two, and you will almost always find a difference. Then again, there is often stuff, such as zinc, amongst the pressed pipe, which we do not get with the sheet lead. I have seen pressed lead soil pipe eaten away (in the trade we use this term) in a very short time. There are to be seen old soil pipes corroded, and much more so on one side than the other. Some of our quasi-sanitary engineers make much ado when they come across this pipe, and more especially should it happen to be in an old ᗜ-trap. In fact so much are they pleased with such finds, that they make great boast about them at their exhibition stalls, &c. They may be known by these their fancy exhibits. I may mention that two or three samples of this are exhibited in Parke's Museum of Hygiene, University College, London. This is easily understood if you will think for a moment what effect acids have upon nearly all metals, lead, as a common metal, the least. Sometimes the very sound of pressed soil pipe tells that it is not all lead; it will ring like so much zinc, and as to bending it, that is out of all reason. True, we know that the lead suffers greatly by the pressure from the ram, but this does not account for all the ringing, as spoken of under the heading, Nature and Properties of Lead. Annealing it is no use. The fact is, it is cheap, and this is one reason for its use. Another is that in London it can always be had at a minute's notice. The third is that we have so very few *good* soil pipe makers. They cannot do it at a fair price; "duffing" workmen make a lot of fuss and bother in their attempt to make it, and they drive the work out of the shop. I may say that hand-made soil pipe can be made quite as cheaply as we buy the pressed, if the proper person gets the work. It is all fudge about good soil pipe giving way at the seams.

Soil Pipe Lengths.

The old lengths are too short. The best lengths for good-sized houses are those which will go or reach from *floor to floor*. Say the house is to be 60ft. high, the basement 9ft. 6in., the ground floor 12ft.; the first requires a length of 11ft., the second a length of 13ft., two 12ft. lengths will answer, and one joint is all that is required for fixing (of course the "tacks" excepted). Again, it often happens that the closet is on the ground floor only; in this case the 12ft. length will do for the upright pipe, and also the bend; or in other cases, where there is no basement, and a closet on the first floor, the ground floor ceiling will not exceed 9ft. 6in. Here you will have 2ft. 6in., the 6in. to go through the floor to drain pipe, and the 2ft. for the bend and pipe to trap. In fact, 12ft. lengths are much the handiest for many reasons.

Sizes of Sheet Lead for Soil Pipe Making.

The following is a simple geometrical plan for obtaining the size of the lead for making soil pipes, which I have invented for this book, and expressly for the use of the plumber, in order that the work may be done accurately and with despatch. First with your compasses draw the circle A E B, Fig. 41, to the size of the pipe required; then draw the line A B across the centre, and from the centre point C erect the perpendicular line C D, make the length of this line three times the radius of the circle; namely, three times the distance from A to C, as shown by the line D C. Next draw the line from point A to point D; this line A D will be half the length of the lead required to go round the soil pipe, which, of course, when doubled will give the required size, at least near enough for all practical purposes.

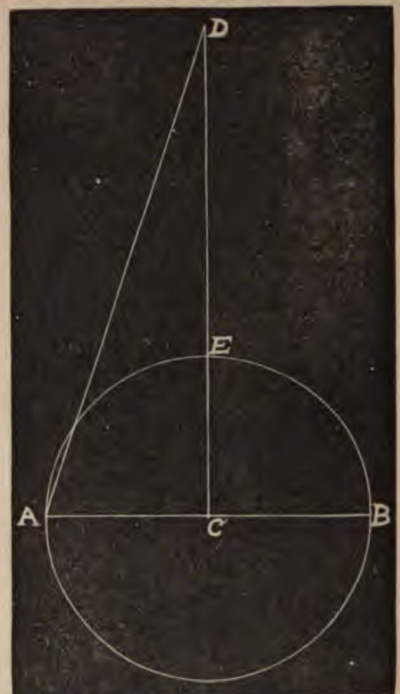


Fig. 41.

Size of Sheet Lead for Soil Pipes in Measurements.

The following sizes of soil pipes require the annexed width: For 4in., the width requires to be, when finished, for 12¾in. of lead 6lb. sheet lead; if thicker lead, allow a little wider because the outside of the lead will have to go further round; 4½in., 14¼in.; 5in., 15¾in.; 5½in., 17⅜in.; 6in., 19in. The lead must be sufficiently wide to allow for trimming and planing up. If cut pretty straight, ½in. will do; but if crooked, 1in. is none too much.

Cutting out Lead.

Having the sizes required, and the sheet unrolled, measure off the size on the sheet (remember to always use the sheet as though it were your own; don't knock it about, or cut it to waste, or roll it up in a slovenly manner); take the chalk line (which should be rolled on a good-sized reel, with large centres or thumb and finger holes), and, with a dry piece of *soft* chalk, chalk the line; then with the labourer at one end, you at the other, snap it over the two marks. Be very particular that the line runs right through and true over the centre of the marks. *The marks nor line must not* be too large. I prefer a good straightedge, and to scribe the lead with a sharp round-pointed bradawl; then take the plumber's pocket or drawing knife, Fig 40, or take the proper or long drawing or cutting out knife described [Fig. 39]. Now, while the mate (labourer) has the cord and you the knife, dip the point into water, and apply it to the line as straight as you can. Don't put too much pressure on, or twist the knife when in the lead, or you will snap off the point, but keep your knife well sharp and upright, the handle low and straight with the line, your right hand about 9in. from the knife. When you are at the end of the sheet, place a small piece of lead under where the line runs, which

prevents your knife cutting the stone or getting on nails, &c. Mind you don't cut your toe, which accident is likely to be caused by the labourer snatching the cord, or when you come to the end of the line, or *across bumps or ridges* in the lead caused by it not being properly unrolled, or by the sheet being knocked about beforehand.

Having cut what you require, take the pocket knife, Fig. 40, and just start the ends; that is, take the sheet in the left hand, and with the knife cut them about 3in. down the line; then roll them up *neatly*, keeping the sides true to the line one with the other, weigh them, and unroll one true and straight on the bench ready for dressing out.

Dressers. [Fig. 42.]

The best-made "dressers" are those which have the handles standing well back from out of a line with the front,

Fig. 42.

or sharp edge of the dresser. Dressers are made of soft wood such as pine, pitch pine, hornbeam (the best wood and most used), box wood, English (as the foreign is too soft and breaks up)

Dressing out Sheet Lead.

The lead must be kept straight and free from buckles; then, with a soft or hornbeam dresser, dress down the edges; but don't dress one side of the lead more than the other, *unless it is rounding*, if so dress the *concave* or hollow side until it is straight (this is done and should be observed in all cases when the lead is crooked, or otherwise required to be crooked; *important* for flashings, gutters, &c.). Then take the "Flapper," Fig. 43, which is made with a piece of stout sheet lead, about 9in. to 12in. long, and 6in. to 8in.

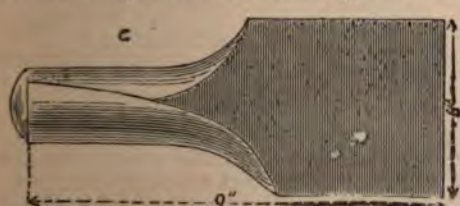


Fig. 43

wide, with the handle knocked to the shape shown, and "flap" or "dress" the lead as before (equal on each side). This dresses the lead free from bumps, &c.

Soil Pipe—Planing or Shooting the Edges.—[Fig. 44.]

This is very important, and must be done with care. The plan shown at Fig 44. is very useful, and saves a lot of time; it can be made in a few minutes. I have never seen it used except by myself; therefore, I am inclined to think it original for shooting *lead edges*. The drawing shows the bench specially made. The edge A must be straight and fixed about ¾in. above the fillet B, which should be smooth and not less than 2½ in. wide. Fix the lead with two bradawls C C, as shown. Instead of the bradawl C in the centre, fix a lath for the planed side or edge. "Touch" (tallow candle is touch) the plane, and have the plane iron set to the work, which is acquired only by practice. The

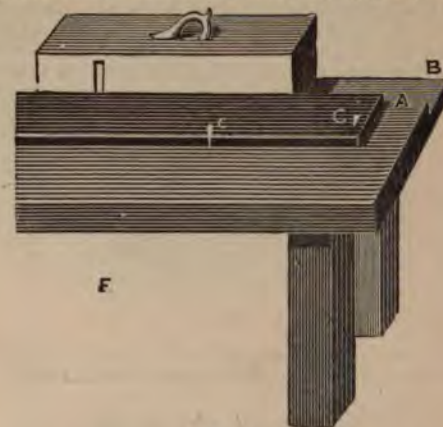


Fig. 44.

plane handle is removed from its original place to the side of the plane; but the regular way will do the work. In this case you do not require the straightedge, as A answers the purpose.

In the ordinary way, you fix the lead on the bench, with about ½in. projecting over the edge, and plane away until you *think* (not know) that the edge is true. Try it with a long straightedge. Plane again until it is right, *or the lead too small* (hence the reason for adopting the above plan). After the edge is straight, turn the lead over and plane the other side, bringing the lead to the required width.

Take a square and square the ends true with the sides.

Turning or Pulling up Soil Pipe on the Mandrel.

Next take the mandrel and place it on the lead parallel with the sides [as shown at Fig 45]. Let the labourer and

Fig. 45.

yourself, and another if you can get him, place their arms upon the mandrel, and with the hands pull the farther side over on the mandrel. Keep on until the lead is fairly wrapped round the mandrel; after which take the soft dresser, and beat the edges flat on the mandrel. Then

Fig. 46.

withdraw the same, and the pipe is ready for "soiling." Fig 46 illustrates the soil pipe at this stage.

Bench Soil Pipe Block. [Fig. 47].

This block should be about 7in. high, 12in. long, 2½in. or 3in. thick, with an easy hole to fit the pipe, as at A. The shop should possess two of every size from 3in. to 6in. It is used for working the pipe on. Sometimes this block is cut in the shape of a V for the pipe to lie in, then

FIG. 47

one block will answer for several sized pipes to lie in; but are not so good, as the pipe revolves in them too heavily.

Soil, Tarnish or Smudge.

This is black mixed up with a little glue, or size and water, sufficient to cause it to bind or not to rub off. For good and particular work the following is the best way to make it. (I worked four years in a shop and never used a bit of soil. After a certain amount of practice, you can do without it; Mr Graham has done the same—in fact, he introduced it to me).

Take a large packet of lampblack, put it into the metal pot and make it red-hot, then let it cool. Take a lump of chalk about half the size of a large hen's egg, pound or break it up very fine or rub it on the rasp; then mix the chalk and black together in water or beer, and well grind the mixture up, either with a muller and paint stone or with a trowel. Whichever it may be, the black must be well ground, *so that no grit can be found*. Make it as stiff as good mortar. Next, have some melted glue (here the glue-pot will be handy), put a good sized table-spoonful with the black, warm up the lot over a moderate fire, keeping it well stirred up from the bottom. Then with an old worn sash-tool (paint-brush) free from paint or grease (which may be had of any painter, washed out) and well worked into the "soil," paint or "soil" (as it is termed) a piece of lead which is *perfectly* free from grease, and hold it to the fire to dry—not too close, so as to burn the soil. Then with the fingers rub it until it shines. If it rubs off, it wants more glue; if it blisters or peels off, it has too much glue, or it is put on too thick; or it may be that the pipe is a little, g reasy; *ever so little will do it*. To take away the grease rub the lead over with chalk before soiling, or rub the lead with glass paper, emery cloth, or card wire. I like chalk best. Some plumbers always warm the soil before using; I never do, as it drys up too much for me. It should be about as thick as cream. [Also see, Soiling for Wiped Joints.]

The Soil Pot.

This should be made of copper, to hold about one pint. In London publicans find the plumbers' soil pots at 2d. each.

Soiling Soil Pipes, &c.

Rub the planed sides of the pipe with chalk to take away all trace of grease; then, if for a copper bit seam, set the compasses 1 in., or if for drawn pipe 2½ in., and then run a line on each side of the edges. Then rub some chalk on the pipe to take away all traces of grease (notice, sheet lead is always to a certain extent greasy); then *neatly* soil (or paint) from the edges to the lines, holding the tool with the handle as low as possible (which will cut true lines and does not spoil the tool or make it bushy); after this take the ordinary cistern or plumbers' hammer (Buck keeps them), Fig. 48, and with the peen or pane A run it between

FIG. 49.

FIG. 48.

the edges. This cleans the insides and opens the edges, to allow the gauge hook to work. The gauge hook is shown at Fig. 49

Shaving, Remarks on, and Shavehooks.

SHAVING LEAD FOR SOLDERING.—This is simply cutting a little shaving off the lead where required for soldering. It leaves the place clean and bright, or untarnished. All shave-hooks should be kept nice and sharp; they are best sharpened with a good-sized saw file. In shaving, care must be taken by the workman not to *drag* it over the lead, or the work will look rivelled. You will find a certain angle to hold the hook by practice only. As you shave, you must "touch" that part, which keeps it from tarnishing.

FIG. 50.

FIG. 52. FIG. 51.

SHAVE-HOOKS.—Figs. 50, 51, and 52 are the shave-hooks generally used. Two sizes of 50 are required, one for general use, and one for the knife part, which should not exceed ¾in. total length from round or back part to the point, for cisterns, sinks, and angle work [see Fig. 327]. The bent and spoon-hooks, Fig. 51, are handy to shave in places where the straight-hook cannot work. Fig. 52 is a bent shave-hook for shaving in awkward places.

SOIL-PIPES, SHAVING.—In shaving soil pipes, for copper-bit soldering, take the gauge-hook, Fig. 49, and with the narrow end B shave the two sides of the pipe ⅛in. wide, and touch as you go on. If for drawing soil-pipe, use the hook at A ⅜in. After this place the mandrel into the pipe, and again true the edges. Take out the mandrel, and now the pipe is ready for soldering up. [See Tacking and Soldering Up.]

Resin Box.

The resin box, Fig. 53, is made of tin, &c., like an ordinary tin pepper box, with a cone-shaped lid, instead of a dredger, coming to a point which has a ⅛in. hole for the resin to come out. Of course the resin must be the black resin, and should be very finely ground up. See

that the two ends of the soil-pipe are square one with the other and come even together; otherwise the seam will be lopsided and all on the twist. Having tacked it every 6 in., take a stick of fine solder, and a good-sized copper bit, well hot, with good face [see "Tinning the Bits"], and

FIG. 53.

lay some solder all up the seam or joint. Then with another iron go all down the seam (let the labourer hold the two ends from opening). Again, making it as smooth as silk. This can be only attained by *practice*. It makes the arm ache if you stick to it. Sometimes it is soldered with a copper bit running on two wheels.

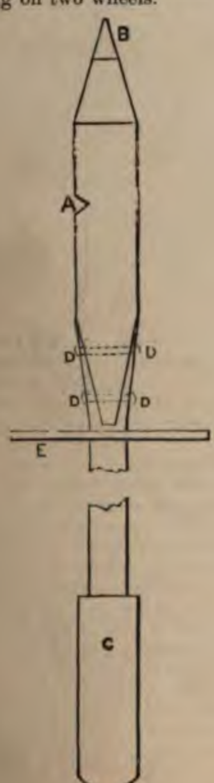


FIG. 54.

DAVIES' IMPROVED COPPER BIT [Fig. 54].—A very simple way to make a carriage is to cut a long slot under the body of the iron, as shown at A, Fig. 54, and with a ¼in. wire to form an axle to join the two pennies together to run the iron on. This is cheap, and works exceedingly well if the slot A and the wire are true.

The proper size for copper bits suitable for soil pipe work is about 5½ lbs. ; nothing less than 4lbs. will do the work of a 10ft. or 12ft. length of soil pipe—that is, to float it properly.

The above copper bit has a shield E, which protects the handle C from burning; the copper is 1¾in. square and 6in. long. This is a large iron, and only fit for soil pipe work, or jobbing about on roofs when the heat has to be got up from the bottom of a high house. [Also see Figs 4 and 5 for copper bits.]

Resin.

THE POUNDING UP OF RESIN FOR THE RESIN BOX.—Black resin is the best kind for the plumber's use ; it should be powdered up under the face of a large hammer, and on a *clean* stone or sheet of iron. This powder should be thoroughly free from small grains or lumps, or it will stop up the hole in the lid of the box, which, as before stated, should not exceed *one twelfth* of an inch in diameter. The resin is put on the seam of the soil pipe by turning up the box, and by tapping it on the bottom with the handle of the shave hook, &c.

Tacking and Soldering up.

When soldering soil pipes with the copper bit, first shave the work ½in. on each side, then go down the seam and tack it with tacks (small bits of solder every 8in. or 12in. apart) like buttons (but not too thick), so as to keep the edges very close together. The labourer presses the lead together while you use the iron. Keep the top edges of the seam level and straight (without bumps). Now, having the length tacked together, next sprinkle a little powdered resin evenly down the seam, then get a nice face and heat on your iron, and with a stick of fine solder go down the seam and roughly solder it from top to bottom. This tins the work, and puts the solder upon the seam. Take care that the seam is in no way bent, or the soldering will never be true when finished. Having the solder thus roughly on the seam, next sprinkle a *little* more resin on, rewarm up the iron, then (with a stick of solder in your hand in case it may be required) place the iron on the seam, and, keeping

FIG. 55.

the handle of the iron at one angle to the pipe, and one equal pressure on the solder, begin at the top and come steadily all down the 10 feet, letting the solder float after the iron as smoothly, truly, and evenly as though it was floated from a ladle. It should appear as at A, Fig. 55.

Preparing and Drawing Soil Pipe or Funnel.

This pipe is prepared in a similar manner to that described in the last chapter, excepting the soiling, which should be 2½in. each side the seam, and the shaving done

wider, at least $\frac{1}{2}$in. wide—$\frac{1}{4}$in. each side of the seam and with the wide part, A, of the guage hook, Fig.49. I shave generally $\frac{3}{8}$in. on each side. "Touch" it, then take a red-hot iron, Fig. 2, and a strap of clean-shaved lead (6 or 7lbs.) 6in. by $\frac{1}{2}$in., well "touched"; then let the labourer hold the pipe together, and a "felt" doubled up to 4 or 5 thicknesses (a piece of old carpet, 9in. or 10in. square) just inside the pipe and under the seam. Next, with the red-hot iron, melt a little of the strap lead on the end of the seam, and burn the lot together, which keeps the ends from opening when the joint is being soldered. There are other methods of burning the lead together, such as with a copper bit, &c. Of course I speak of doing so with the iron as being handy at the time. So far prepared, take the metal pot, Fig. 3, containing $1\frac{1}{2}$ parts of *lead and* 1 *of tin*, but after a lot of practice, the ordinary plumbers' solder will be fine enough to use, and with the ladle, Fig. 1, pour a little solder across the pipe, to form "tacks" at every 8in., not leaving more metal on than is necessary for the work. Of course you must put more on than required, for the purpose of tinning the lead; but this is knocked off with the thumb or fingers before it sets, and whilst the labourer is holding the pipe together. This done, comes the most important bit, "drawing," which is, however, easily done after a *lot* of practice. In the first place, you want a good sponge, about a handful, and a "swab" pot (a pot to hold two or three pints of water—a copper pan will answer very well); or instead of a sponge a cone-pointed pot the shape of the resin box will answer the purpose. It must be made with an air-hole on top, which, when covered with the forefinger, forms a valve; the hole in the bottom should be only large enough to admit a stream of water 1-16in. in thickness to run upon the joint which is governed by the air-hole on top. This swab can is filled by dipping its lower end into a pail of water. Next a "knocking-off stick," which is a piece of lath cut to a point, to push off the little bits of solder which may hang to the side of the seam; next, and most important, a good "swobber," or, as it is called in the West of England, "swabber" (a labourer up to the work).

The labourer must be very attentive and quick; not to bustle about, but to be ready at the proper moment. His duty is, when the pipe is being drawn, to form a crow quill size stream of water from his sponge, which must be done at intervals of time, and about every 3in. apart, to keep the seam from opening, and with the knocking-off stick to knock away any little bits of solder that may cling to the seam. The swabbing is effected with the sponge or swab can. Suppose the solder to be on the seam, 9in. finished; then at every 3in. to 5in. squeeze a little stream of water across the solder. This cools it and keeps it from opening or running through. The labourer should not get too close to the plumber, but pay particular attention, as it very much depends upon him how the seam will look. It should appear like so many shillings or spots all the way through the seam. If the labourer does his work well the pipe will look neat; if badly, the solder will be running through and pockmarked.

Now for the plumber, who should be firm and confident. Take the large ladle in the right hand, the iron [4lb., Fig. 2] in the left; have the pot in the middle of the bench, with a tidy heat, and three-parts full. (Let the ends of the pipe be fixed down, so that they cannot rise.) Take a ladleful, and with a good swing pour the solder on the top (end) part of the seam, and a little on the soiling to get the heat up, having it floating for about 9in. to 12in.; take the iron and *draw* it on each side of the seam (hence the name of drawing), so as to cause the solder in the centre of the seam to thoroughly float for about 9in. to 12in. in length, and the metal on the sides of the seam will flow away off the seam, known as the surplus metal, the surplus running off the pipe and leaving the seam floated. The labourer then begins to swab, which is to prevent the pipe from opening up; remember you must not wait for him. I repeat this, knowing its value, which cannot be too well learnt. You keep to your work, pouring on fresh solder and drawing away, until you get through the length. Good! That is number one, and looks first-rate. Pick up the metal and do another.

If a "teat" (a bit of solder) should run through, take a red-hot iron with the handle straightened out, and burn it off. [It is a common saying in the workshop if a "teat" runs through, "Oh! there will be a branch put in just there."] I need not say this is bad work, and must not be left. [For burnt-up soil pipe, see Lead-burning.]

Stacking Soil and other Pipes.

Soil and other pipes should be properly stacked away. One of the best methods is shown at Fig. 56; it is simply a

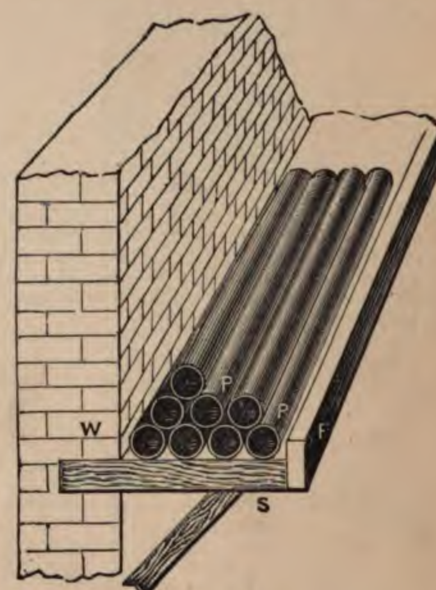


FIG. 56.

shelf having F nailed on the front; by stacking the pipes carefully away, you often save yourself the trouble of driving.

Driving Soil Pipes to Clear Dents.

This is done by driving a short length of mandrel, known as a "drift," through the pipes, to take out the dents or bruises. For this purpose a piece of $\frac{3}{4}$in. gas pipe, or a piece of ridge-roll, is frequently used as a kind of rammer to drive the drift through the pipe.

The drift, or mandrel, should be made of deal, and be 1-16in. smaller than the soil pipe, and be made with a little tapering, having the end rounded. The mandrel will be all the better if a little "touch" be rubbed over its surface before it is driven through, but be sure and keep it free from grit and dirt. If the pipe be very much indented, it is best to send a small mandrel through first, so as to raise the dents gradually, and finish with a good fitting drift. In this manner you can bring up your soil pipe quite round, even though it has been knocked or bent about to the extent of flatness.

Trumpet-Mouth Wastes.

[*Also see Over-flow Waste Pipes.*]

Trumpet mouth wastes are made by cutting the sheet lead tapering as at A F H, Fig 57, say, the small end to be for an inch pipe, then the large end should be three times that size, viz., three inches across the top; the top end should be cut off square to the desired length, which is done as follows: Having your lead cut tapering, continue the side lines until they meet at a point, as at A; then from this point with your compasses (or with a lath and two nails, or bradawls) strike a circle or arc, H, K, F, on the top lines, which will give you the exact shape for the lead to be cut at the mouth, so that it may stand perfectly upright; this lead will appear rounded at the mouth before it is turned up. You shave, soil, and solder as though you were making soil-pipe, after which you turn a bead on the mouth end to stiffen the same. The bead is turned by simply knocking the edge of the lead outwards, which may be done with a small dresser, mallet, &c. More upon this subject will be said in our Inside Plumbing Work, which see.

FIG. 57.

LEAD BURNING.

Introduction.

In directing the attention of my readers to this subject, I am at once introducing them to one of the most interesting and useful branches of the plumbing trade, without a practical knowledge of which no plumber should consider himself entitled to be ranked as a first-class workman. I consider that it is the best class work when properly done, because the joints, so to speak, are coalescent. It is a common impression amongst many in the trade, that lead-burning is quite a new art; this, however, is an error, as it is considerably older than is generally supposed. This invention, indeed, like many others, has been doomed to share the usual fate, and has many claimants for its originality, the common idea being that it was invented by Count de Richmont, of France, who, it is reported, instructed one Luke Herbert (a patent agent of the time) to patent the system in England, the patent bearing the date of 1838, though statistics prove that the method was much practised in England far anterior to that date. This only goes to prove that we cannot depend upon dates in the case of many most useful inventions connected with the plumbing trade—for example, ventilation, traps, &c. It is often extremely difficult to arrive at the real origin of many inventions. We read, for instance, of such things as reaping machines being used on the plains of Rhoetia, A.D. 70, or 1814 years ago, and at least 1600 years anterior to the date of our first patents.

Now, since this art of lead-burning was known, as we are aware, at least forty years ago, and much talked about, why is it, we may reasonably ask, that this valuable invention is so little known, and only practised by a very few of the leading members of the trade? The answer is, that the machine, as also the bellows necessary for the work, has not been perfected till within this last year or so, and further, sound instruction, in connection with experiments, theoretical and practical, is much wanted from the hands of the practical workman; for it is folly to expect sound and practical instruction from the hands of an unskilled teacher. Such there are to be found in London, professing to give instructions in this art, and who, in reality, know no more about lead-burning than the students themselves—in fact, explosions appear to be their forte. These book-plumbers are also to be found scribbling away, professing in this manner also to teach the whole of the science and art of lead-burning. The teachings of these men only tend to impede progress. They follow in the old rut, which requires new metal to pave the way. They tell a tale about the old square-box machine, and recommend zinc cuttings. I may here remark that there is more difference between this and the modern machine than there is between an old-fashioned brick barrel and a good glazed pipe-drain. The old square machine is clumsy, and totally unfit for general work about a building; whilst the modern one is handy, good working, and not unsightly. Then again, there is another reason. We have not many good plumbers proficient in the art of lead-burning who are willing to work in the building trade, no matter how large the firm may be. The few that can burn, as a rule, are chemical works men, and they are, generally speaking, of so selfish a turn of mind that if a lad or stranger asks their advice respecting the art, they are unwilling to give any information—I suppose for the simple reason that they think, if a direct and intelligent answer be given, that the knowledge will henceforth and for ever be imported from them, and that this is all they will ever be able to learn. Such men generally consider themselves very clever, but their conceit is a hundred-fold greater than their ability, and they should disappear from the company of their co-workers, for they can do better without them. This greediness or unwillingness to impart knowledge is one of the greatest mistakes in the world, and altogether a wrong feeling, based upon a wrong principle, which I will endeavour to overthrow, for experience teaches me that the more a man knows, the more he can learn, and the more willing he is to impart that knowledge, by the very imparting of which he improves himself, thereby becoming more valuable to himself, to society, and to the world at large.

Lead-burning by the ærohydric blow-pipe is accomplished by burning a mixture of atmospheric air and hydrogen gas, producing a very vivid and intense flame, and which after much practice is as manageable as the pen now in my hands.

The principal use of this method is for joining the edges of lead together without the use of solder, and is done by melting the edges to be joined in such a manner that they will run or flow together, or if there should be an intermediate space, some of the same kind of metal must be melted in with the outer edges, so as to flow and form one solid substance. This being the case, an article burned together in this way must be homogeneous, and consequently, the various parts will all withstand one and the same chemical action and heat, and, therefore, before they can be either joined or separated must all melt or be otherwise destroyed. Another advantage is that all parts expand or contract equally, and that chemicals act on such work uniformly. The ærohydric blow-pipe is only a modification of the oxy-hydrogen blow-pipe, invented by Dr. Hair, of Philadelphia.

Lead-burning does not require so intense a heat as that obtained from the working of the oxy-hydrogen blow-pipe. It may be interesting to know that with this machine, platinum (the hardest metal known to melt), will instantly flow under the action of this blow-pipe, it having a heat of no less than 3,992 degrees Fahr., or 3,370 degrees above the melting point of lead. Some further idea may be formed of the intensity of the heat acquired, when it is explained that china ware may be fused into crystals, or carbonate of magnesia melted up before the flame of this lamp.

The Lead Burning Machine (Description of).

The areo-hydrogen blow pipe, or machine, or generating chamber, is made to work something after the manner of Hero's fountain, which brief description will suffice until its construction is practically explained. [See Fig 58, which illustrates this machine at work.] A is the top or acid chamber, M the bottom or generating chamber. P the dip communication pipe, which dips into the acid water, as

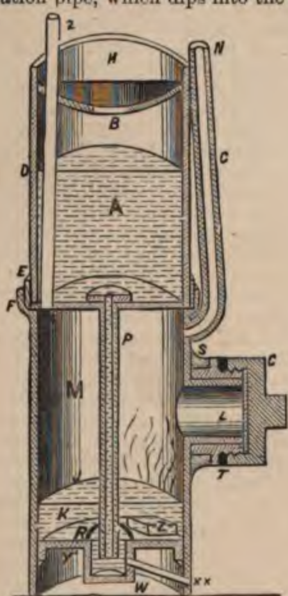


FIG. 58.

shown at K R. The action is as follows:—Suppose Z to be a piece of zinc, say 6in. long, 3in. wide, and 1in. thick. Let A be some strong acid water, say five of water and one of the strongest sulphuric acid, which is sufficiently strong to sharply attack the zinc. Now, as soon as the acid acts upon the zinc, hydrogen gas is generated, and rises in small bubbles upon the face of the acid, and creates pressure, which, if not relieved through the pipes 2 or N, or otherwise, will, by its pressure press or, so to speak, blow the acid water back up the pipe P, and will continue to do so until the whole of the acid water is forced from the chamber M into the top chamber A; but should this pressure of gas be relieved or released from the chamber M, then the acid water by its gravity will again run down the pipe P, and again will be allowed to attack the zinc Z, when more gas will be generated, and in quantity according to the strength of the acid and the amount of zinc surface.

Lead Burning Machine (Construction of).

The lead-burning machine is best constructed as follows: With a suitable sized piece of lead whose thickness may vary according to circumstances; for stock or shop machines 6lb. or 7lb. lead should be used, but for portable machines 4lb. or 5lb. will answer. Having determined upon the substance of the lead, we will suppose it to be a 9in. machine [as shown at Fig. 59]; these pieces of lead forming

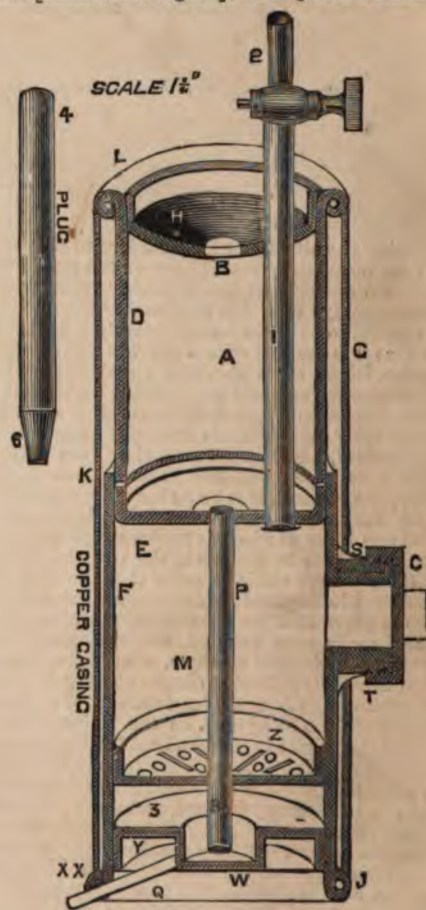


FIG. 59

the sides will then be about 3ft. by 1ft. 6in., 3in. being taken up to form the beads J L, and 2in. for lap at K, leaving the machine to stand 2ft. 7in. high; plane up the edges, and square the top and bottom; next turn the lead upon a mandrel, not necessarily the size of the machine, and get the seam burnt up. Here the first difficulty presents

itself, and one that has kept hundreds of men out of the lead-burning branch of the trade.

To get over this difficulty, and for a trial machine, instead of burning up the joint, solder it with as coarse a solder as you can use, for it is the tin in the solder that the acid eats away, hence the reason for using coarse solder (this will last you a month or so to practice with until you can burn one up properly); next turn the bottom bead J, and if you do not intend to case the machine, turn the top bead. Having got so far, cut three pieces of 5lb. or 6lb. lead for the bottom, middle, and top, which must be large enough for the turn-up of edge or flange; then burn the pipe P, with

Fig. 60.

the bottom end cut as shewn at U in ACID PIPE [Fig. 66] and the pipe I to the middle partition, and fix and burn in this partition as shown in the diagram to the top part of the bottom chamber of the machine. Great care should be taken in making the joints perfectly watertight, for you cannot do anything to them after the machine is put together; next shave or clean the inside and outside parts to be burned together, and slip the top chamber into the bottom chamber, say 2in., and let it fit quite tight; then burn it together, as directed and shown at Fig. 89, and at L 90, and at Fig. 92, and at Side or Horizontal Burning. Now form the bottom, with the well W and grating Z, to be fixed as shown in the diagram. From the top of the grating to the bottom of the acid pipe should be 7in., the grating to have a quantity of ⅜in. holes. The use of this grating [a plan of which is shown at 7, 8, 9, Fig. 60], is that the zinc may rest upon it, so that all the acid may drain into the well of the machine, and also to keep the zinc perfectly dry when not generating gas. This is very important. Caution: Care must be taken to fix the grating or strainer in such a manner that the small parts of the zinc cannot get through and into the well, otherwise the zinc would be continually acted upon by the acid, and the machine would constantly generate gas when not required, and will be throwing it up the pipe P R in bubbles at intervals, which will escape into the air, perhaps endangering confined places. This escaping gas of course means a waste of acid and zinc; the same thing will happen should the zinc have very rough surfaces, because the acid hangs to the zinc. If the holes in the strainer be too small, the machine will work irregularly, and cause the gas to jump, by reason of the oxide of zinc closing them up; the same effect will be produced should the oxide get into the well in large quantities to stop up the acid pipe. Now fix the top H, by cutting a hole for the pipe I, and a 1½in. hole for the pouring in of the acid and water; burn it to the top edge of the machine, as shown. This top, should the machine throw up, prevents the acid from flying about, especially if you cover the hole B with a loose piece of sheet lead two or three inches round, with handle or lead ring to lift it by. Next fix a 1½in. or 2in. piece of lead pipe into the side of the well, as shown at Q; this serves to empty the machine, and to drain off the oxide of zinc, &c. A 1½in. or 2in. screwed plug will be best fixed on the end of the emptying pipe for closing. Copper or lead is the best material; but for such plugs a 2in. boss and an iron plug may be used; but this plug if made of iron often requires renewing, so that a lead one will be the best. Now fix as shown at C T, a 4in., 5in., or 6in. cap and screw; the latter size is best, because it admits of large pieces of zinc being put into the machine. This cap and screw may be soldered on, as the acid is not supposed to come into contact with it, though, if you can keep the brass work covered with lead [as shown in Fig. 58], it will be all the better for the extra trouble. Then fix a ⅜in. good gas cock on the pipe I, as shown at 2, but at least four inches above the top of the machine, out of the way of the acid. Next get a 1½in. block cut to fit in the bottom, to support it. The centre of the middle partition may be partly supported by the acid pipe resting upon the bottom of the well, but care must be taken in cutting this pipe, so that the end be not stopped up by resting on the bottom, otherwise it will hinder the acid water passing from one chamber to another. The bottom of the acid pipe may be cut as shown at T U, Fig. 66. If the machine is to have a casing K (a thing I recommend), use copper, and keep it well blacked over with Japan black. This casing answers two purposes: it prevents the lead from being damaged, and causes the machine, by keeping the heat in, to work better. The joints or seams of the casing may be soldered up.

The Old Square-Box Machine.

There are many other methods of making the machine, but the principle remains the same in all. Fig. 61 is different to the former machine. In this diagram, it will be noticed that the cap C is on the top, and the well W at the side, and continued along the bottom. The zinc is put upon the bottom as at Z.

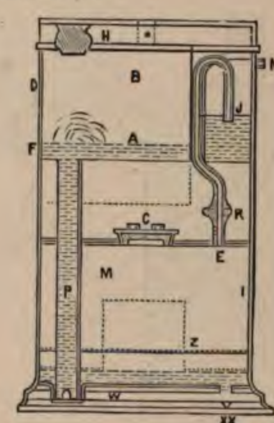


Fig. 61..

In this machine there is another, or third, chamber J, called the safety chamber, also called Gurney's arrangement, and is especially suitable for the oxy-hydrogen blow pipe. It is nothing but a large tube—say 4in.—having within it the gas pipe R J, Fig. 61, first taken up to the top as shown, and bent over for the end to dip into not more than 1in. of water. In this way the gas passes up the gas pipe and through the thin layer of water into the tap, and out of the small pipe N into the india-rubber tubing, and so to the burner (called a blow-pipe). This prevents the possibility of fire getting into the gas generator from the burner, etc. But with this arrangement the gas comes off with more water, which gets into the tube, and is an awful nuisance when at work. When such is the case, take the lot of tubing and hang it end

upwards to drain out, which may take hours to accomplish; of course you can get it out quicker by blowing down the pipe when suspended end upwards.

CAUTION:—When you can, always blow out the flame as soon as the burning is done, and turn off the gas afterwards. Unless this precaution is taken the machine, if exhausted of generating power or crystallized, is apt to "draw back" (viz., on cooling, a partial vacuum is formed) the gas, air, and light with it, even through very long lengths of pipes, and consequently explode, not only destroying the machine, but life. It is also necessary to turn off the wind tap, for the gas has a sneaking desire to even explode them, particularly when in the hands of the unskilled.

The Machine Siphon.

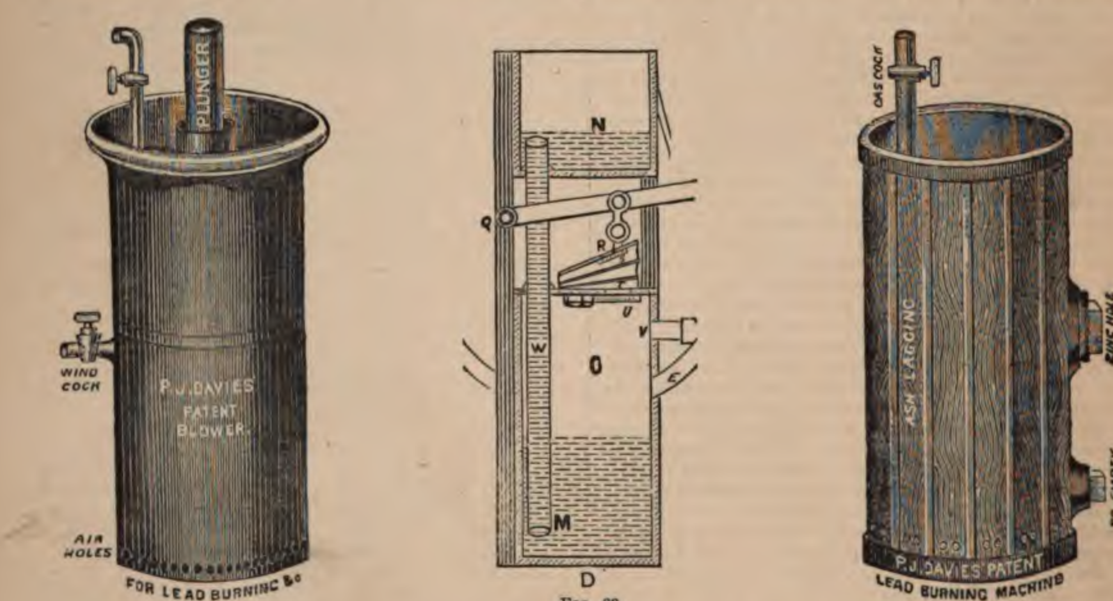
The Machine Siphon, Fig. 62, is nothing more than a common gas siphon made for the purpose of catching the water partially given off by the steam from the acid, water, etc., within the machine. The inlet pipe A is best taken down into the bottle part B; the gas exit pipe is marked D. For my part, I prefer to make C with a piece of 1in. pipe, about 5in. long. A and D are both ½in. gas pipe soldered on to B; the rubber pipes are slipped over the ends, and of course securely fixed. F is a strap of 6lb. sheet lead bent to form a hook to hang over the rim L of the machine, Fig. 59, and as shown at Q, etc., Fig. 68.

FIG. 26

taking about, its weight being about 10lbs. The barrel of the plunger is protected by being placed inside the body of the blower; its construction is similar to that shown at B, Fig. 63. A child can work it for hours together, and being governed by a water column and small plunger gives one of the steadiest flames I ever handled. N.B.—This bellows is also very handy for blowing foul air out of deep wells, &c.

Bellows for the Blow-pipe in Lead-burning.

The bellows is of the greatest importance in some kinds of lead-burning; for heavy work such as from ¼ inch plate to say 18 lbs. lead, almost anything may answer provided you can get the desired pressure, but when you come to 2, 3, 4, or 5 lbs. sheet lead you require the flame quiet and not dancing and popping up and down like a will o' the wisp. For this reason I have introduced the new figures B, D, Fig. 63, D being worked by a bellows and B with a plunger, or both plunger and bellows may be at times worked with advantage. The plunger and water column bellows is the simplest and best kind of hand-worked bellows known, and is made as follows: N, O, are two zinc, copper, or lead cylindrical vessels, say 9 in. round and 18 in. high, one fixed above the other, the bottom one being enclosed. Through the top of the bottom vessel is fixed a 1in. or 1½in. copper, zinc, or lead pipe. On the top at R is fixed the bellows, having inlet and outlet clocks R, U, with a lever or handle, which may be worked by hand, foot, or otherwise. The action is as follows:—Turn off the wind-cock (see small cock on top of B, Fig. 63, or N, Fig. 68, and about three parts fill the top cylinder with clean water, and as long as the cock is shut the water will



B D A

FIG. 63.

not run down the pipe W into the lower cylinder; turn on the cock and it will thus, forcing all the air out of the bottom cylinder, work the handle and force more air into the bottom, this will force the water back up the pipe W, and so long as you work so will the blower. Some burners like the water to be always on the bubble, which is best unless you can depend upon the water in the cylinder being kept at one level, or the wind at equal pressure.

Machine Lagged.

At A, Fig. 63, can be seen an improved lead burning machine and blower; the machine is lagged with ash and well protected, the additional expense is but small, and it is just the machine for knocking about the country. The blower shown in Fig. 63 is also very good for

Lantern Bellows.

This is another kind of bellows, which is very handy for jobbing about, and may be made round, something like the bellows of a concertina, fixed in an upright round box, usually about 8in. high and 8in. or 10in. in diameter; it may be worked by a pedal, or by a plumber's counsellor (labourer or boy) seated upon the top of the bellows, with a lever in hand. The top board of the bellows is best worked with a bedstead spring, or a dead weight may be used; but this latter, being heavy carriage, is somewhat objectionable.

Foot Bellows (Double Action).

Fig. 64 shows the foot bellows, the bottom being worked up with a spring S. It is very handy for odd and out-door work, and is made as follows: The three pieces of board forming top, middle, and bottom, are connected with leather closely nailed, as shown by the dots in the ends of the boards. The valve is fixed near E, opening inwards; there is also a valve in the middle board opening downwards; between the top and middle board is fixed a spiral spring to keep these two boards expanded; there is also another spring, as at S, to push up the bottom board, which tends to keep it closed. The bellows thus formed is now by the middle board fixed to the four posts as shown at P, and a wind-pipe H, fixed to the bottom part of the bellows as

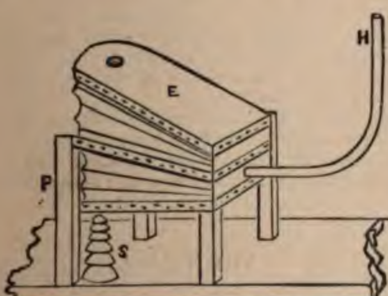


FIG. 64.

shown, or this pipe may be fixed near P, which will be handier than if fixed where shown. Its action is as follows: By depressing the top board, the air from within is pressed through the valve in the middle board, and thus the bottom board opens, when the spring tends to press the air out again through the wind-pipe H. By allowing the top board to rise, the valve in the top opens and allows fresh air to enter, which may be pressed out again, and so on. The bottom board is here shown to be worked up with a spring, but if a little weight and lever is fixed on the underside of the board near the pipe H, the bellows will work more regularly, because the spring when compressed gives a greater pressure at one time than another, which interferes with the wind when regulated to one pressure.

Foot Bellows (Single Action).

Fig. 65 is a single foot bellows, but shown in conjunction with a regulator R, which may be a simple piece of thin leather nailed across the top to form a diaphragm, and which may be weighted to suit any pressure of wind, or this may be in the shape of a blown bladder weighted down in such a manner that one uniform pressure can be obtained. Of course these bellows may be worked in conjunction with O, Fig. 63, or A, Fig. 66.

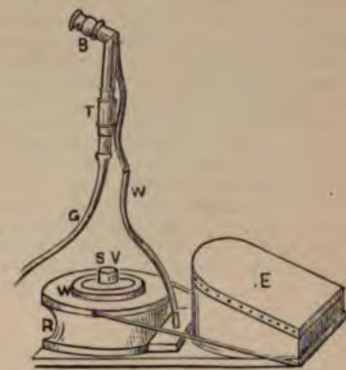


FIG. 65.

P. J. Davies' Bellows.

The bellows illustrated at Fig. 66 is of an improved form, and by far the best yet invented, and is made as follows, the scale being 1½in. The frame A T U 2 is an oblong wooden box about 1ft. 9in. or 2ft. long, height about 9in.

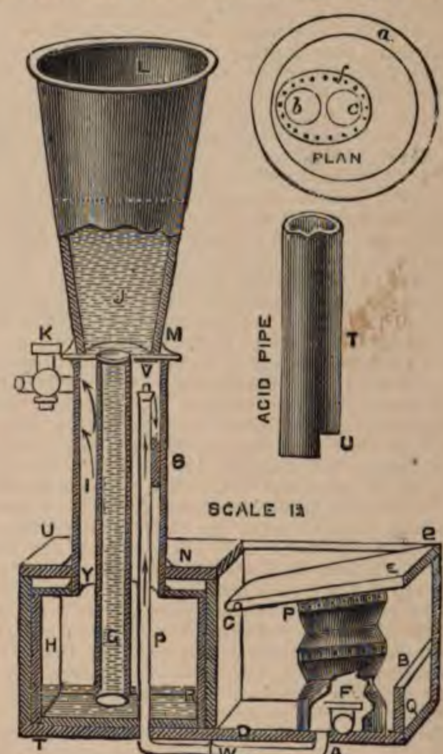


FIG. 66.

and width about 9in. or 10in. The half end B is fixed to answer as a stop for the treadle, which prevents the bellows spring being injured by excessive pressure from the foot; the box has also the partition C for the support of the side

lead of the cistern. U N is the top board, having a 4in. hole for the wind-chamber S. The top and bottom parts, or boards, of the bellows B are made with 1¼in. mahogany; the diameter should be about 1in. less than the width of the box, that is, if the box is 9in., the top should be 8in. Round the inside of these boards should be turned the groove A [see plan], to receive the ends of a spiral spring, such as is used for sofas or easy chairs; this spring must in size equal nearly that of the boards, and stand, when not compressed, about 15in. high. In the bottom board the aperture C is made for the inlet valve and pipe, and the aperture B for the outlet pipe. We now come to the inlet valve. This is simply a ¾in. ground-in *short* spindle valve, which must be of such make that the weight of the valve will not interfere with the passage of the air, for if too heavy the air will flow with the bellows sluggishly. This valve if a ground-in valve must have the sides with a good taper—in fact, they should be as flat as they can be made; otherwise the valve will work itself tight and will jamb itself, thereby causing the bellows to jump and work roughly. The spindle of the valve should have plenty of play through the bridgeway of the valve. This valve should be soldered on to a piece of ¾in. pipe properly flanged for bedding with white-lead to the board; the flange should be cut large enough to admit of both the inlet valve pipe and the outlet valve pipe being soldered to it. Then the whole can be bedded and nailed down on the board together. Having got so far, next fix with wire or otherwise the sofa spring to the bottom board, and over the valve and outlet pipe; also fix the spring to the top board; this will have the appearance of a concertina frame without the leather. Now provide the leather casing. The best material for this purpose is sheepskin of a medium thickness; this must be properly sewn together, and perfectly windtight; the length required is about 7½in. or 8in. Next insert a cane hoop in the middle, to keep the sides distended while drawing in the wind; then with ½in. tin-tacks and an extra band of leather about ¾in. wide, nail the leather to the bellows boards. Now, with two screws of suitable length, fasten the bottom of the board to the bottom board of the box, seeing that the screws do not press through the bottom board of the bellows; fix the outlet pipe as shown at W, ready for connecting by a blown or copper-bit joint, and bend the inlet pipe up the side of the frame as shown at F, Fig. 68. Next line the close cistern H R, Fig. 66, having a piece of ¾in. lead pipe, P, soldered in the bottom, and long enough to reach to the top of wind-chamber as at V, and to bend round the bottom, so as to meet the outlet pipe A from bellows as shown at W. Having the cistern made, and top and bottom soldered on, fix the ¾in. spindle valve V on the pipe P, and to a suitable height, say 10in., above box; next fix the 1in. water column or dip pipe G to the top of the box, steady it with a flange joint at Y, let the pipe go to the bottom of the box, but with the end cut to the shape as shown at U at the bottom of the ACID PIPE; this will allow a free passage for the water when the bellows is at work. Next bore two 1in. holes in the top of the cistern near the soldered pipes, to allow the free passage of the wind from the bellows to press upon the top of the water in the cistern (to be explained further on). The wind-chamber S is made with a piece of 5in. soil pipe of suitable length, say about 12in., by first soldering a piece 2in. long to the top of the lead cistern; then fix the top board N and taft down the end of the short piece of 4in. lead pipe over the top board, and solder the 4in. wind-chamber to this; this flange will keep up the top of the lead box. Next turn or flange over the top of the wind-chamber as shown at M to receive the middle partition, and the pipe V P, to the inside as shown at S, then cut a piece of the sheet-lead V for the partition, and to this solder the top-end of the watercolumn pipe G, as shown in diagram. Prepare the funnel L J, and solder it together, with the middle partition to the wind chamber as shown; fix a ¾in. gas-cock as at K, to the top of the wind-chamber; after this fix the treadle E by putting a 10in. ⅜in. or other bolt of a suitable length through the end, and through the two sides of the frame, as shown at C; then with two stout screws fasten the top of the bellows to the treadle, and in such a manner that the bellows will work nearly upright; make the joint at W, and the bellows will be completed. *Turn off the wind-cock* K and fill the bellows with water to about half-way up the funnel J; then open the wind-cock and let the water run down, and the bellows is ready for use. Notice that, if you get too much water, it will rise above the valve V, and most likely will by degrees work its way into the bellows, thereby softening the leather, and causing it to work very flabby and badly. For the same reason the bellows must not be left exposed to the rain, etc.

In theory the construction of the bellows is as follows:— Suppose the wind cock K to be open, then by water being put into the funnel L J, Fig 66, it will run down the water column pipe G and into the box H P, so that by closing the wind cock K no water could get through the pipe G (because there would be no escape for the air held within the box H P); but now suppose the wind-cock K to be shut off, and the box full of water, and an additional quantity of wind pumped in through the valve V, as the bellows is worked so will the wind within the box become compressed, and will press upon the surface of the water at R with sufficient force to cause it to flow back up the pipe G, until all is forced out, when, if the bellows be kept at work, the air will bubble up through the water (exactly as the machine would when throwing up); now open the cock K, and there is an exit for the air, when the water will flow back in proportion to the amount of wind allowed to pass through the wind-cock.

This is one of the best experiments to illustrate the manner in which water is forced up the suction pipe of a common pump by atmospheric pressure; also it is useful in explaining the principle of siphonic action.

The Tubing.

This is made of pure india rubber; the general size is ⅜in. It should be thick enough to prevent kinking or flattening when being pulled about; wired pipe is of no use for this purpose, as it will not last, owing to the acid which is constantly given off from the machine (½in. piping will be better than ⅜in. for long lengths, or where there is much fear of the gas condensing, and so forming water.) You will require three lengths of this pipe according to your work. one piece for the hand pipe [see HAND PIPE, Fig 68], generally about 5ft. or 6ft. long. This is to connect the tube and nipple to the breaching pipe piece Z, and cocks shown at B, V, Z, D, Fig 68. You will also want a piece for the wind pipe L W N, to connect the bellows with the cocks, and another piece for connecting the cocks D, K, with the machine, or machine siphon, P Q, Fig. 68. You will also want a piece about a foot long, as shown at R, for connecting the siphon Q [also shown with enlarged view at Fig. 62] with the gas machine. Fig. 67 shows an enlarged view of the breeching cocks. This is simply three cocks on one bent brass tube as at I J K. E is the gas tube leading from the machine, H the wind tube leading from the bellows, C the tube leading to the hand pipe burner, I being the wind cock, which must be regulated to suit the work, K the regulating cock for the gas, and J the turning off cock. After the wind and gas cocks are once regulated to the work, they need not be touched for some time, or until circumstances require it. The use of this breeching is to connect the two gases, *i. e.*, the hydrogen from the machine, and the atmospheric air

from the bellows. At this point the two gases meet and travel on through the single pipe V [see Fig 68], thence to the

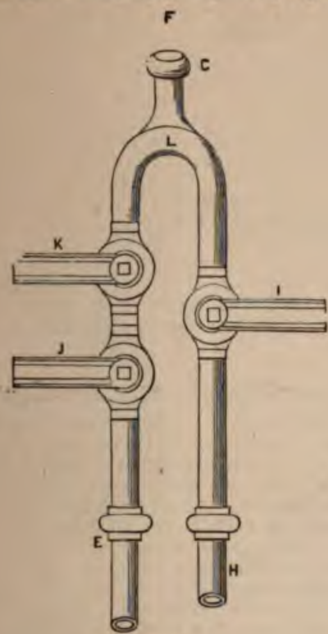


Fig. 67

burner, and J, Fig 67, shuts it off, so avoiding running backwards and forwards to STOP COCK on the machine [see Fig 68].

Quality and Quantity of Gas.

The mixture or quantity of each gas required, suitable for lead burning, is two parts of hydrogen to one of atmospheric air. This produces perfect combustion, and when working in these proportions there will be seen just in front of your work *when burning* on cold lead a little water, and which is being constantly formed by the two gases.

Two parts of hydrogen to one part of atmospheric air answer every purpose of the plumber, but for the oxy-hydrogen blow pipe two volumes of hydrogen and one volume of oxygen is required, the difference being for the two different blow pipes that in the aero-hydrogen blow pipe the air is diluted with, at least, from three to four times its bulk of nitrogen, which reduces the strength of the blast to the required heat for lead burning. But the combination of pure hydrogen and oxygen in the proportion of 2 and 1 will give a heat at least six times as powerful, suitable for melting such metals as gold, silver, copper, brass, aluminium, zinc, or iron.

The Behaviour of the Machine.

Sometimes, after the machine has worked excellently for some considerable time and then allowed to get cold, standing, say, during dinner time, when you return to work the gas will all of a sudden sink down and there remain. You turn off the cocks and in, say, five minutes it will be up again; you, thinking it is now all right will try again, when down it will go, and so on for five or ten minutes, when all at once it will set to work beautifully. This is after the acid has again got warm. Sometimes you may be surprised to find that the machine will not work, although the acid is up. This is due to the fact that the bottom of the machine is the coldest, and the acid pipe has become crystallized up, or it may be that the pipe is bunged up with sulphate of zinc. Sometimes the machine, quite independently of any of the above causes, cannot be got to work, and you will be inclined to put a lot more fresh acid in, but to your surprise this will not alter its condition. Then you may fancy the zinc is not right; this may be the case. Perhaps it is coated with sulphate of zinc, which should be washed off, or the zinc may be found all right. If so, try more water and the chances are that the machine will work well.

Machines too Small.

If the machine is too small for the amount of work, use a larger proportion of acid and keep the zinc clean and with plenty of surface. This will ultimately prove much against you, as, if it be cold weather, the machine will soon be crystallized or clogged up with sulphate of zinc, the reason being that more zinc has been dissolved than the water will hold in solution, so that small machines must work hard and hot, and, therefore, are more subject to crystallization than the large ones. As to whether or not the machine is being worked hard, you can be guided by the heat given off. Of course, more hydrogen can be obtained from the acid if the machine is worked "*hot*," though the disadvantage attached to working the machine hot is that on it cooling down to 70° F., the crystals form very quickly [see "Cleaning out the Machine," "Crystallized Machines," "Clearing Crystals out of Machine," &c.].

Blowing up the Machine and Cleaning out.

Sometimes the machine will not work because the zinc has become coated. In such cases, and to prevent this, "blow up the machine" at night or when you leave off work. This is done in the following manner:—When the acid is in the top chamber [A Fig. 58 and Fig. 59], with a well-fitting wooden plug [see PLUG, Fig. 59] stop up the pipe P, which will keep the acid up; then take the cleansing plug out of the pipe X X, and let the little acid run out, take off the large cap and throw in some hot water, which will wash out the sulphate of zinc, &c., and leave it ready for the next job. For small machines this should be done every night. I may here state that I have a small and favourite machine which will run on for a matter of three hours without attention, the size of which is 2ft. by 6in. round. I state this on account of the extraordinary time that it will run, without attention, for so small a machine.

The Theory of the Machine, and Charging the same.

I have, when writing upon the Fig. 58, briefly referred to the action of the machine, and will now give a fuller description. For this, again refer to Fig. 59. First shut the gas cock 2, take off the cap C and place upon the strainer Z some lumps of zinc as large as can be put in through the cap C; next screw on the cap C, and see that the cap X X is screwed up. Now place sufficient water into the top part of the machine as will fill it up to about A; say this is 5 pints, or 5 gallons; if 5 pints take one pint of the *strongest* sulphuric acid, and put this into the water; then open the gas cock 2; the acid water will then run down into the bottom of the machine, and attack the zinc. The zinc takes the oxygen from the water and releases the hydrogen, which rises in small bubbles through the water; now close the cock 2, and with this action going on, the bubbles soon fill the space M with hydrogen gas, as shown at the curved lines in the bottom part of the machine Fig. 58, and gas pressure is generated, and, as in the bellows as before explained, forces the water back up the pipe R P, and into the top compartment, until the acid water is all removed from the surface of the zinc, when the action is

discontinued; open the cock 2, the pressure is at once relieved, and the acid runs down again, attacks the zinc. and generates more gas. The chemical process of the work—perhaps I had better explain it—is as follows:—The zinc takes oxygen from the water and forms oxide of zinc, which, though insoluble in water, is quickly dissolved by the acid, forming a salt called sulphate of zinc, whilst hydrogen passes off in a gaseous state. This change that occurs may be explained in the following equation:—H2 SO4 + Zn = Zn + SO4 H2.

One ounce of Zinc is sufficient to liberate from acid water about 2½ compressed or machine gals. of gas, which, when pure, is the lightest of all known substances, being fourteen times lighter than common air and sixteen times lighter than oxygen.

In handling this gas be cautious, as it is very inflammable and extremely dangerous; if it explodes, it will probably produce deafness, if nothing worse. It is a colourless, transparent, tasteless and inodorous gas. Though it cannot support life it is not poisonous; but, if taken in large quantities into the lungs, it displaces so much air that the result would be insensibility; the voice would become squeaky and occasionally unheard. These contingencies have to be guarded against.

The Heat given off by Small Machines.

If the machine is a small one, it has now become heated, and should now be kept at work, for if it be left to cool down, the chances are that you will require a fresh quantity of acid.

Clearing the Crystals out of the Machine.

The machine while working should be kept warm, and never allowed to get below 70° F.; otherwise, if it has been worked hard, and the exhausted liquor allowed to stand, it will soon become crystallized, when it would require a pail or two of boiling water to be thrown in to dissolve the crystals, and clear them away. Sometimes the machine is cased with felt, &c., to keep it warm. If the machine does not make gas fast enough, it must have the acid stronger; if no gas can be obtained, then look to your zinc. Probably you will not find any left; of course then you must put in more. Should you require to do this without emptying the acid from the machine, take the rubber off the gas-tap, at R, Fig. 68, and with your mouth, blow up all the acid water into the top chamber, but be careful not to blow too strong, for this would cause the acid to bubble up, the splashes of which would, in all probability, come in contact with your face. N.B.—To prevent this it will be quite as well to place a small piece of lead over the hole H, which will also keep foreign matters from getting into the top chamber. Of course you would only apply your mouth under extreme circumstances, and when the gas cannot be got up otherwise; with a little judgment it can be blown up with the bellows. When the acid is all up, take the plug 4, 6, Fig. 59, also WOOD PLUG, Fig. 68, and plug the end of acid pipe P; this will prevent the return of the acid; *next, as quick as possible, open the gas cock 2, Fig. 59, to prevent the machine being strained with pressure from the generation of gas (should it be able to do so)*; you may then take off the large cap, throw in a pail of fresh water; next examine for zinc. *Important Caution.—Do not take fire near enough to explode the machine.*

The Machine and Bellows fitted up.

Having explained the construction of my lead-burning machine and bellows, I will now proceed to explain and illustrate the whole, exactly as I exhibited it at South Kensington before the competitors for the prizes offered for plumbing by the National Health Society, March, 1882, and as used by myself and men in different parts of England, Wales, and Scotland. Fig. 68 illustrates the whole arrangement. The gas is generated in the machine, and conveyed through a *stout*, pure rubber tube, P, X, K, to the regulating cock D; from there through the breeching piece Z and through the hand-pipe V to the nipple A; at the same time wind is pumped from the bellows through the rubber tubes W, and through the breeching, where it is regulated by the spanner cock L, to meet and to mix in a certain quantity or proportion as before explained, with the gas at the meeting point of the breeching Z, and through the hand pipe to the nipple near A.

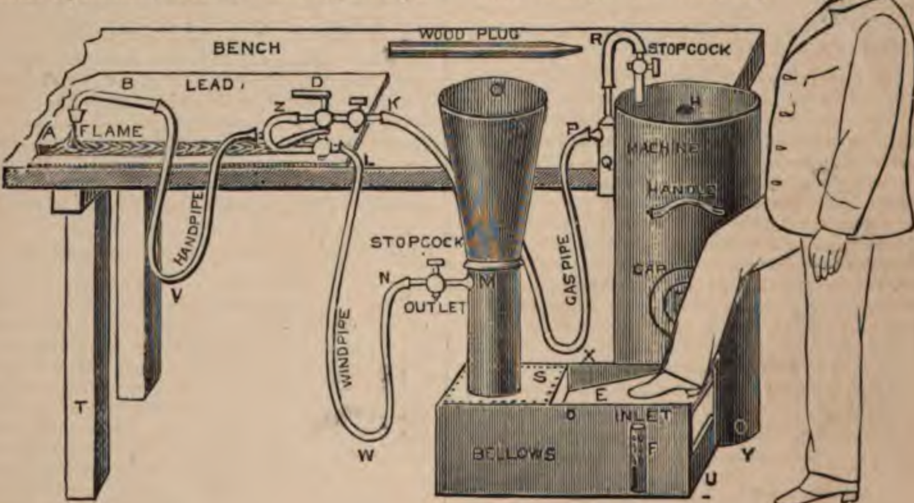


FIG. 68.

This flame illustrates the burning of two pieces of lead together at A, Fig. 68, known as flat-butted work. The blow-pipe, 5, 6, 7, Fig. 69, is made of stout brass tube, ¼in. bore; the nipples 8, 9, 4, are drawn full size; 3 is a plan looking from the back, and 2 is a plan looking from the front; these nipples are made to screw off or on to the pipe; the sized hole for the jet must vary according to the class of work done, and also the workman. The ordinary size is from 1-32 to 3-32 of an inch, or larger, if required for very heavy work, such as from 12 to 28 lb lead.

In another case you would most likely fall into error in attempting to line a cistern, and would meet with almost unconquerable difficulties. The proper mode is to line it as a zinc-worker would—that is, so that the seam will stand out of the angle some three or four inches, and make one to lap over the other.

Preparing Work for Burning.—Flat Burning.

Take two pieces of lead, and prepare the edges to butt together. Shave the edges the exact width, as shown at C D, Fig. 70. Do not use soil, touch, or resin, nor handle it after it has been shaved. Shave the lead, and put it together, as shown in 70. Be sure and shave all parts that touch and are required to be burned—viz., back and front of the lead that touch each other.

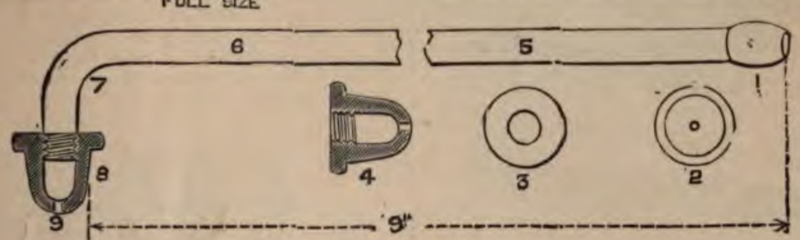


FIG. 69.

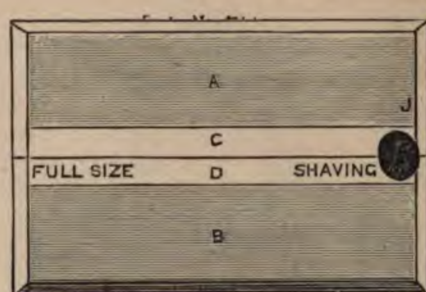


FIG. 70.

The student is particularly cautioned against attempting to burn before he has thoroughly mastered the principles upon which the machine and bellows are worked. He should be able to answer any of the questions relative to this work, which will be found at the end of this work.

I shall now proceed to explain Lead Burning, and those who wish to become proficient in the art may easily do so by following me step by step through these pages, practising every line. Do not try to learn it all at once. As for me, I think that slow and sure is an excellent motto. Remember that perfection is attained by degrees. I, when a boy, and indeed now, take particular notice that I get the elementary work before I attempt to excel, for without being grounded in this part of the work, no man can expect to become proficient.

Once more, before you begin burning, let me say;

Pray call perseverance to your aid,
And let the foundation be well laid.

To give my readers some idea of the extent of lead burning now executed, and the consequent importance of being a competent "lead burner," I may here say that Messrs. Pullen & Sons, the well-known solder and cast-lead O-trap manufacturers, burn on the average upwards of ten miles per annum, and though at first sight this quantity may seem absurd, it is nevertheless the fact.

In order that plumbers may not from my teaching in these pages be discouraged by failure at the commencement of their efforts, I think it as well at once to tell them that, in order to succeed in the art of lead burning, they must be prepared to follow minutely the instructions, and not be surprised that their early essays are unsuccessful. A large share of patience is also required before competency is reached. It is not at all improbable that one of the first difficulties that will be met with, will be in regulating the wind to the gas, as the proportions of wind and gas, and also the pressure, require such exactitude to produce the true aero-hydrogen flame, that it is vain and ridiculous to expect to succeed on a first attempt.

Another difficulty that you will probably have to contend with is, that there may be a foreign admixture of chemicals in the acid, or foreign matter in the zinc, which would cause the lead not to flow together, but rather to blacken your seam. Even an experienced lead burner not unfrequently has almost insurmountable difficulties to contend with in burning lead that is either impure, or where there are two quite distinct kinds of lead to be burned together.

Gas and Air Regulating.

Having your machine fitted up and ready for use, as shown at Fig. 68, I will instruct you how to regulate your gas and wind, which is of the greatest importance. For this, see Figs. 71 and 72. Take the pipe A B, Fig. 71, and hold it lightly between the fingers and point of the thumb, as shown, so that the pipe will just be on the balance from A to B; hold it as easy as possible; next have a lighted candle, or better, an oil lamp, burning close to your work; now turn on the STOP COCK of the machine [Fig. 68], also the shutting off cock K, and open the regulating cock D; shut the wind cock N. Now the machine being just charged will have a quantity of air mixed with the first lot of gas, and for a minute or so after being turned on this mixture will not ignite, because at first there will be too much atmospheric air in proportion to the gas. After a minute or so has elapsed, the hydrogen will predominate, and will ignite with a pop and kind of a bluish flame, perhaps roaring, and most likely the size of the flame will be exceedingly large, or perhaps small, and pop out; it will then, if the pipe be held in the flame of the lamp, make a sudden pop, and will be rekindled. This may go on for

half a dozen times, when, all at once, it will most probably increase in size, resembling the flame A B C D E F, Fig.

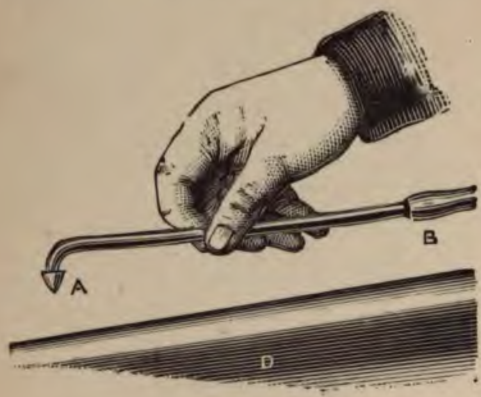


FIG. 71.

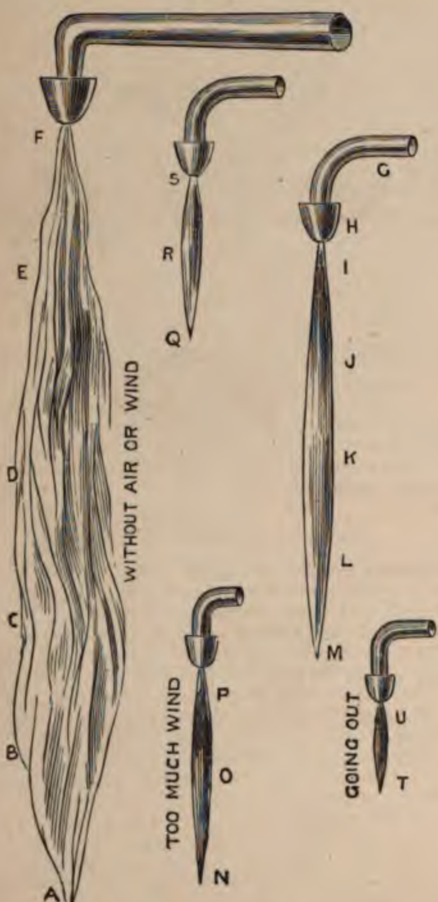


FIG. 72.

72 : it then, perhaps, will have a yellowish appearance inclined to red tint, which is an indication that there is no air present. This flame is very rugged, having but very little heat. Now, pump your bellows water up into the funnel, [see Fig. 68], and turn on the wind cock N, and your flame will be seen to alter both in size and colour; and most likely, your flame will appear as at H I J K L M, Fig. 72, but will not remain so, but will become as at P O N; then will still get smaller as at R S Q, then to T U, and finally out. (If so, immediately close the shutting off gas cock K.) This is simply because your gas is overcome by the power of air or wind, which must be reduced in quantity by just tapping the spanner of the cock L, so as to very gradually reduce down the pressure of wind until the mixture of air and hydrogen gas is in proper proportion. Now, in regulating this proportion, it will be best to begin again by shutting off the wind-cock N, and turning on the gas-cock K. Now, light the gas, which will appear rugged and

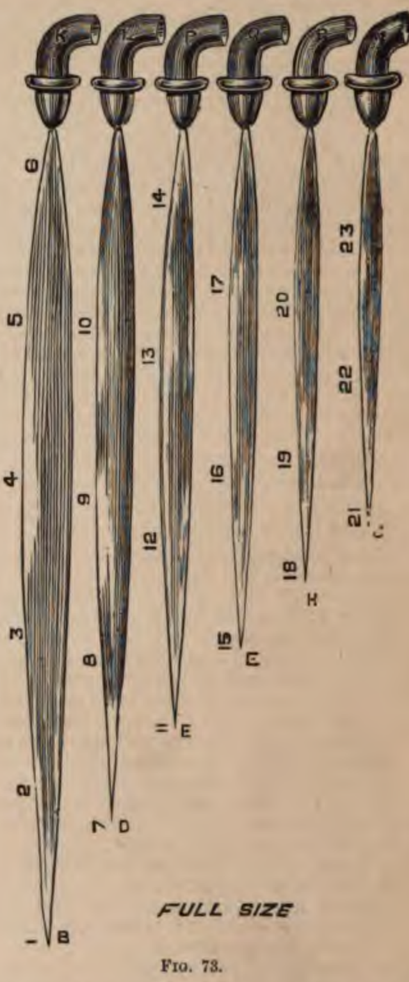


FIG. 73.

soft, and by lightly tapping the spanner D, reduce the gas down to about the size of the flame shown at 11, 12, 13, 14, Fig. 73. Now, shut the wind tap L, Fig. 68, and open the wind tap N, your gas being still burning as at 11, 12, 13, 14, Fig. 73, excepting that you will not get that fine point shown there. Now just open your wind tap spanner L, *but very slightly*, still by degrees, and take particular notice of

the difference you will have in the flame; it will get more pointed and become a bluish soft purple and pencil-shaped intense flame, in shape similar to that shown at 18, 19, and 20, Fig. 73. There is a wonderful difference between the flame A B C D, Fig. 72, and the flame 18, 19, 20, Fig. 73. The one is rugged and useless on account of its shagginess, whilst the other is useful on account of its sharpness. It is compact, and too much care cannot be taken in selecting this proper-shaped flame, which is entirely done by the regulating the amount of gas and air by adjusting the spanner cocks D and L, which govern the amount of air and gas necessary for the size of the burner.

Nipples and Cleaning the Nipples.

It may happen that you cannot possibly get a clear flame, and all you can do by regulating the wind is to no purpose. When such is the case, examine your burner, as the point may be out of shape or dirty, and must be cleaned with a match or other pieces of wood pointed to a needle point, which, by inserting into the hole of the nipple and twisting it round, will clear away any dirt which might have lodged there.

Fig. 74.

Burning.

Having seen how to regulate your flame from a rugged to a sharp jet, you may now try the effect of the strength of the flame upon a stick of lead, which should be run in a triangular-shaped iron mould, having sides about ⅜ of an inch wide (similar to that of a fine solder mould) shown at L, Fig. 76. For this purpose, take the stick of lead in the left hand, holding it nearly horizontal, or if anything, with its end (from finger and thumb), say ½in. out of the level, with the point of the stick leaning downwards. Now, in your right hand, take the flame, about the size of that shown at A B C, Fig. 74, and apply the end A to the end of the stick lead, and try what effect the fire has upon the lead at this point A; then try it with the stick of lead placed at B; then try it by placing the stick close to the nipple at C, and see at what point the lead melts easiest. Repeat this until you are satisfied. Now, having mastered your flame, so that you can tell how to procure a pointed one, and as near as possible the best position to obtain the strongest heat, which would be at about one-third distance from the point A, Fig. 74, next try this under different sized nipples and flames similar to those shown at Fig. 73. Now I will instruct you in flat burning.

Flat Butted Burning.

Having properly mastered the regulating of your flame, now proceed to do some flat burning. First, prepare your lead as shown at Fig. 70; here are two pieces of 6 or 7 lbs., lead butted together, shaved and ready for burning. Now take your stick of metal in the left hand and the flame (burners, as a rule, call the flame a "flam") in the right, holding it as before directed in Fig. 71, and just nip the end of the stick lead so that a bead or button will fall on the joint as at J, Fig. 70; then bring down the point of the flame and melt the bead of lead together with the two edges of the lead, taking care to apply the hottest part of the flame to the centre of joint. Let the whole flow together, raise the flame instantly, and with all speed melt off another bead to drop just upon the inner edge of your last (and at the same time that the whole is in a molten state) at about G in SHAVING; then melt this bead and the two edges as before, and so on from J to D, Fig. 70.

Notice.—It is important that you hold the blow pipe straight and in a line with the shaving, and nearly level over that part which you have burnt, as illustrated in Fig. 75. To put the pipe before that part which you have burnt is burning back-handed.

N.B.—The stick metal L, Fig. 75, is shown leaned rather too much to the left, but its true position will be acquired by practice. You must continue to practice this class of burning, occasionally trying the flat and then the lapped until you feel yourself thoroughly competent to do the work with freeness and ease, and until you can execute it so that it shall, when finished, have the appearance of that shown at Fig. 75, which is taken from a photograph of some work done by myself expressly for this work.

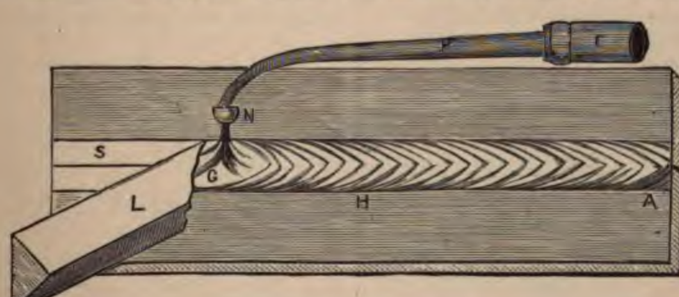


Fig. 75.

Lapped Joint Burning.

Fig. 76 represents a lapped joint; this is often done in cistern work, and is nothing more than the horizontal or upright work done flat, or on the bottom of the cistern. Care must be taken to properly clean the under side of the top lead, as also the undercloak, otherwise the lead will have a poor chance of being properly burnt. This burning is done in a similar manner to that before described, with

this difference, that instead of burning the two edges as in the butted work, you simply burn the lapped work shown at J K, Fig. 76, by burning the outer edge in such a

for flat or butted work, say, to commence with, that the flame should be the size of that shown at N O P, Fig. 72; work with this size for a time on, say, some 4lbs. and 5lbs.

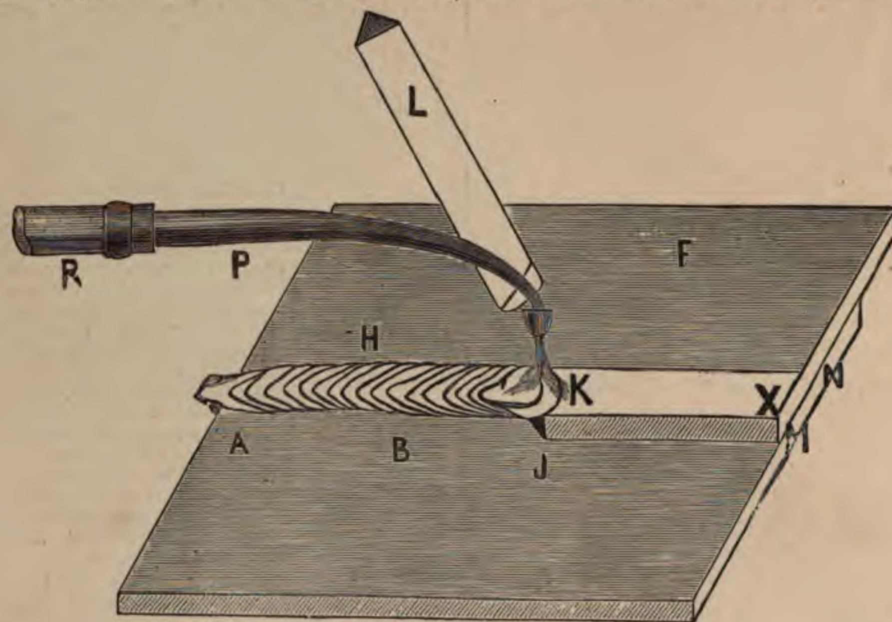


FIG. 76.

manner that it will run from J. towards K, using your Stick lead as may be required.

Horizontal or Side Burning.

[*Graduated for learners.*]

This is illustrated at Fig. 77. To commence learning this, first lay the front lead over the back as shown, and upon a board; lean it at an easy angle of, say, about 25°

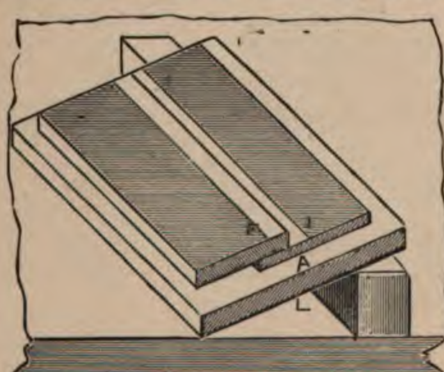


FIG. 77.

off the bench—that is to say, take a piece of board about 2ft. long, 9in. wide, and 1in. thick, and lay the lead flat upon it; tilt the edge of the board, say 4in. or 5in., up as shown at L., Fig. 77. Let the front lead F, be thoroughly cleaned, and lap over the back lead as shown. Now take the flame, which should be smaller than that used

lead; then as you improve you may increase the size of your flame to that shown at 21, 22, 23, or 18, 19, and 20, Fig. 73. To commence this burning, the front edge at A. F. must be started, and burnt down to form a bead, as at I and A, Fig. 78, then keep this bead alive, and with the *point* of the flame just touch the back lead until it just begins to brighten, when the two being in a state of fusion will attract each other (the front lead by preference flies to the back lead), and just at this very instant draw or lift the flame, after which quickly bring the flame down upon

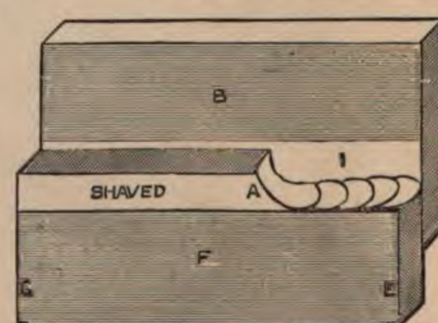


FIG. 78.

another portion of the front lead, so as to burn another bit; and so again bring the hot part of your flame down to bear upon your back lead, heating the whole of the lead up until it is just liquefying, as in the former case, until your length is burnt. The reason why this back lead continues to stand is on account of the back part being cooler than

the front, therefore you must proceed to practise this with caution, and by degrees raising the edge of the board until you can burn with it perpendicular. The method for holding the pipe for this work is illustrated at Fig. 79. the former of which on being sighted up the arrow G, will show the block as it stands when fixed upon the bench for learning horizontal burning. It also illustrates the pipe. Fig. 79. This position may be seen by sighting with the left eye up the arrow H, when the work will be shown inclined from L to K, and also from G to A. Keep practising at this until you have elevated the block or work to a perpendicular line. If you sight with the right eye up the arrow I, the pipe and joint will appear as it should when doing the work. When sighting up these arrows

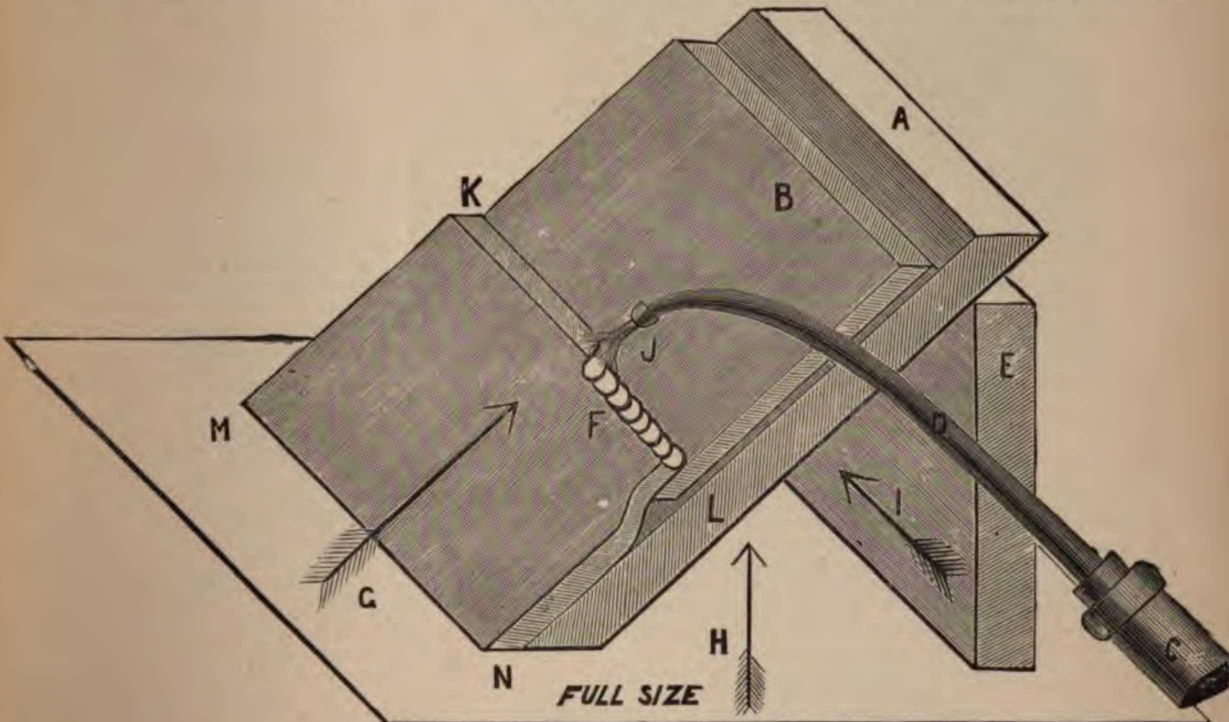


Fig 79

It is almost unnecessary here to mention that you will not require stick lead for horizontal or upright burning, but simply melt down the front edge of the lead, say $\frac{1}{4}$in. to $\frac{3}{8}$in., for the necessary supply.

H or I, the engraving should be held above the head, and in a vertical direction, but not so when sighting up the arrow G. I shall next draw your attention to the proper position for holding the pipe when burning horizontal or

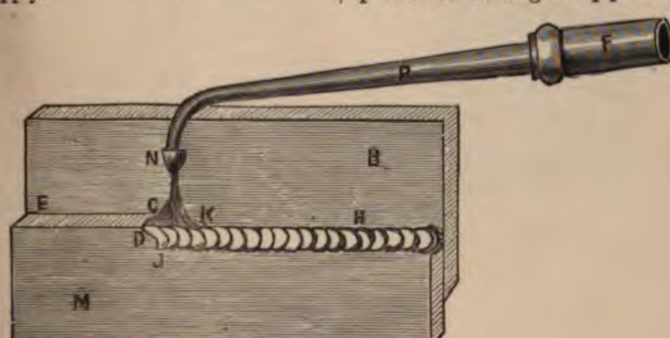


Fig. 80

Upright Burning.

To practise this, first you must be a fair horizontal burner; then begin by preparing the work as you did the horizontal burning, first by elevating the block from M, upright work. I have before said that it is necessary to hold the pipe in a line with the work, as at Fig. 75. The pipe should be held as shown at Fig. 80, when at work on side or horizontal burning. And if you turn the drawing

so that E may be the top, and sight this drawing from B towards E, it will then illustrate the pipe as held for upright burning.

Hints upon Upright and Horizontal or Side Burning.

Here the pipe in Fig. 80 is in a line with the seam, it is also held near about level. Now refer to Fig. 81; let M be the bottom lead, and B the top.

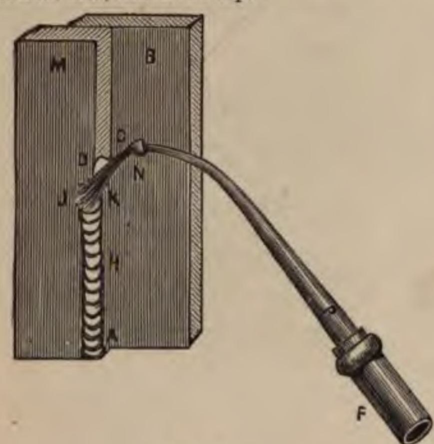


FIG. 81.

Here the back part of the pipe at F is cocked too high, which appears very awkward, and is so, as far as regards horizontal work. Now sight the engraving from A towards B, and the pipe is about in a right position for upright work. There is a right and a wrong way to lap your work necessary for good upright burning. The lead for upright

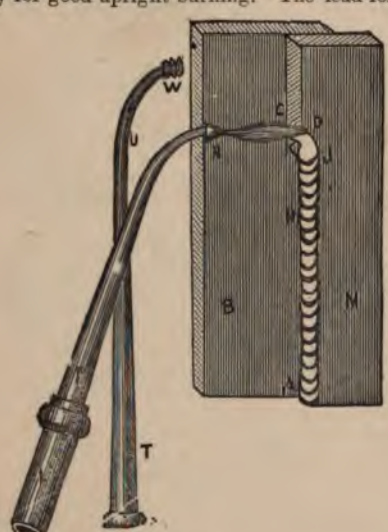


FIG. 82.

burning should be lapped for the overcloak to come from left to right, so that its edge shall present itself to the right hand as shown at Fig. 79, when sighting up the arrow I, also as shown by looking at the diagrams 80 and 81, by making M the top and A the bottom. By referring to Fig. 82, the lead is shown lapped the wrong way and is for left-handed burning, which at a glance may be seen. This should never be done unless it be in places where it is unavoidable, as backhanded work is, as it implies, awkward to execute. You should practise this with the left hand. Fig. 82 illustrates back-handed work with flame just in the act of nipping down a bead of lead.

It is all important that you do not nip off too large a piece at one time, nor too small a piece, for if too large it will perhaps drop off, or cause the work to be uneven. If too small, the work will be light and most likely not sufficiently strong for the substance of the lead. As you proceed with this work you will find that you can make your work stronger according to the amount of prepared lap and the amount of lead you nip down, the method you adopt in biting and bringing down the bead of lead from the front edge to form the joint, the strongest work being according to the amount of metal bit off at each movement.

Fig 83 illustrates side burning, and P Q R the end section of the same. S T illustrates the back lead bit. M N O is its appearance after crystallization, and L K J the section of front and back lead before being burnt.

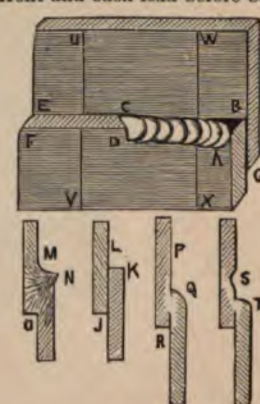


FIG. 83.

Fig. 80 is some horizontal burning and a photographic specimen of lead burning done by the author at a contest of plumber's work at South Kensington Museum on the first of March, 1882, in the presence of about a hundred plumbers and architects.

Fig 84 illustrates an exact photographic specimen of upright lead burning executed by the author at South Kensington Museum in the year 1882.

It may not be out of place for me to submit to your notice the following, which is an extract from the *Plumber and Decorator* of April 1, 1882, page 76, headed the "National Health Society"; and as it bears upon the practical work which we now have in hand, there is the more reason why I should now introduce it :

"We were pleased to see that so much interest was taken in the competition by Mr. Ernest Turner, Mr. Shaw, and several other gentlemen of influence connected with and interested in the trade. Some lead burning was done by Mr. P. J. Davies, who, by the way, has already made himself somewhat famous by his inventions and various workings in the different branches of the plumbing trade—the apparatus that he used being evidently quite new to many of those present, to wit the following conversation :—'Olloa, 'Arry, what's this 'ere?' 'Eh! blowed if I know; some new fake for making ice-cream, I 'spose.' But this is only *en passant*. The machinery in question for lead-burning was really first-class, and attracted great numbers,

if not all of the interested persons in the building, immediately it was placed upon the bench, eager to know and understand for what it was intended.

"In the manipulation the first thing done was to unscrew the large cap, to enable those present to inspect the inside;

Fig. 84.

then the bellows were filled with the necessary quantity of water; next four pints of water were put into the machine, when all were again invited to inspect.

"Mr. Davies then poured out three-quarters of a pint of acid and showed it round, afterwards pouring the acid into the top part of the machine, when it ran down into the lower part, and instantly the gas (through the cap being

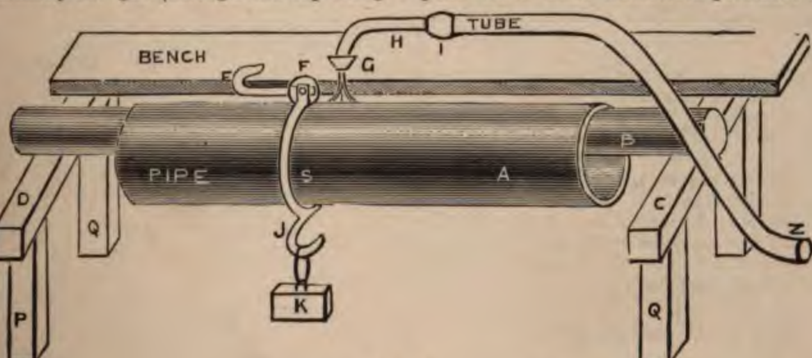


Fig. 86.

off) was seen generating and rising in small bubbles to the surface of the acid water. Again, Mr. Davies invited inspection, but was particularly cautious that no fire was near. The cap was then screwed on, and the pipes connected to the machine and bellows, and after some few minutes popping and jumping of the flame, in consequence of the air being in the machine, a tremendous blast of fire was produced, which, owing to excessive pressure, was, for some minutes useless; but the machine being in such practical hands, was soon reduced to obedience, and Mr. Davies performed some excellent specimens of flat and side or horizontal burning. Mr. Turner now asked for some upright burning. This was, owing to the excessive blast of gas, rather difficult to touch; more especially as the operator had only the one nipple. However, a little time and patience resulted in the flame being reduced and in the production of some first rate specimens of upright lead-burning, having the appearance of split peas carefully laid in order.

"On being invited, a few other plumbers present essayed to apply the lead burning machine, but it was evident to all present that it was handled by fresh hands, though, as

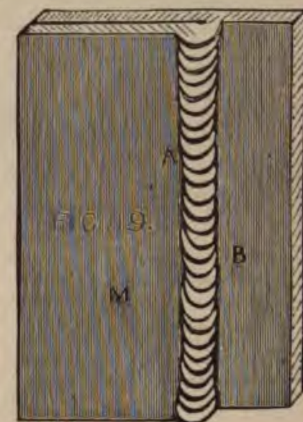


Fig. 85.

Mr. Davies remarked, some of them, with a little tuition, would soon become efficient lead burners. The articles we have published on this important branch of the plumbing trade having been now exhibited and explained practically by the author, they should interest the practicians generally, and induce them—seeing its advantages, as they must—to persevere to make themselves proficient in the art. We could well do with a few more members in the plumbing trade who would take as much trouble to instruct brother tradesmen as Mr. Davies does."

Fig 85, illustrates a photographic specimen of upright lead burning executed by Mr. James Pullen, Junr., but was not done with a view of its being for a specimen. It is extraordinarily good, and in no way was it selected for this purpose but is Mr. Pullen's ordinary work.

Soil Pipe Burning.

[Also see Soil Pipe making.]

Prepare the joints in a similar manner as when for soldering up, except the use of soil, touch, or resin. Pull and dress round the mandrel as illustrated at E, Fig 45, and as finished ready for closing together as shown at AEB, Fig 46. Next put it upon an iron mandrel, which

may be made of, say, 2in, 3in, or 3½in iron pipe, and as illustrated at B, Fig 86, or an ordinary mandrel will do if covered with sheet iron.

Fig 86 illustrates the method of soil pipe burning as invented and practised by the author. In this diagram

FIG. 87.

may be seen the pipe placed over an iron mandrel, B and supported upon two fixed tressels. Commence to burn at B, and proceed towards G. I have invented and introduced a roller, F, to be kept about 1in. in *front* of the flame.

FIG. 88.

This prevents the heat from drawing the lead off the mandrel, which enables the lead burner to proceed rapidly with his burning. Such work will have a herring-bone appearance, as illustrated at Fig 87. When this tool cannot be had, at first, when learning, burn the seam slowly (in the manner known as button-burning), but see that the amalgamation of the burning is perfect. The shape of button-burning is well illustrated, full-sized, in Fig 88. This is a slower process than herring-bone work, and for learners a flame is required about 2in. long which may be increased in accordance with their practice.

Pipe Joint Burning.

This is done by first opening the pipe as though it was for a slip joint, which must be made to fit quite tight, and to enter at least three quarters of an inch. Clean the inside and outside to the depth you require for burning; which will be about three eighths of an inch. Then clean the male part, and put the lot together as shown at E, F, A, Fig 89. Commence burning as though you were burning horizontal work [see Side or Horizontal Burning]; begin by first nipping the front lead, say as at A, Fig 89, down a quarter of an inch or so, then work from right to left as shown. Burn as far as you can round the pipe; then if the pipe be fixed in such a position as to prevent you burning all round it, turn the pipe and burn the other part left-handed; or it may be necessary to do the left-handed work first; if so, the part burnt will have the appearance of that part shown burnt at A, Fig 92. Then again begin to burn as directed at A, Fig 92. Here you will find the shape of the beads to be laid in two different directions. Take notice of the difference in the two above specimens of burn-

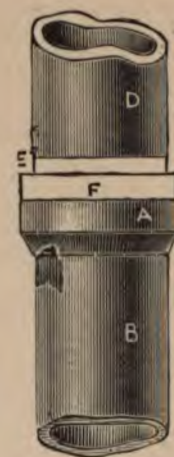


FIG. 89.

FIG. 90.

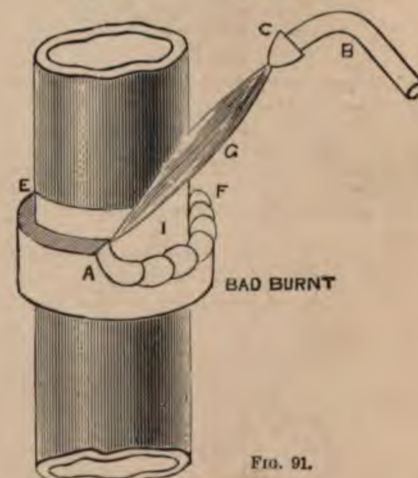


FIG. 91.

FIG. 92.

ing. That shown at A I F, Fig. 91, is not burning at all, because the back lead is not amalgamated with the front. But now take notice of that shown at A, Fig. 92. Here the beads lie close, and are amalgamated with the back lead. Good burning always appears to lie close together, and is united to an easy sweep, whereas bad burning has a rugged and kind of stiff, stand-up appearance, as at Fig. 91, and at I, Fig 90. L Q, Fig. 90, shows the burning done properly.

Burning Branch Joints.

To prepare for these joints proceed as will be hereafter directed in my following paragraphs on branch joint making [see Fig. 93]. Take care to work up the lead well square and thick, so that the male or branch lead may be properly supported. The stand-up lead should clip the branch lead at least from a-half to three-quarters of an inch. The lead should, as before spoken of, be properly cleaned, and should be when finished as that shown at Fig. 93.

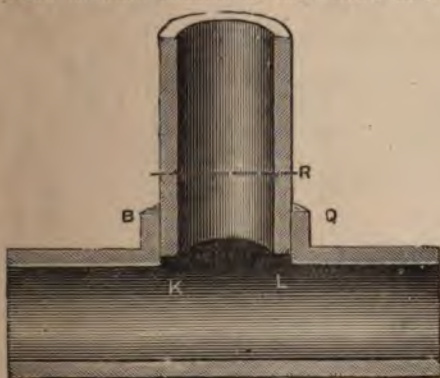


Fig. 93.

It must fit tight all up, and not open at the bottom near K L, otherwise your beads will fall through. Use a small burner and begin by nipping down the lead as directed at A and A, Figs. 94 and 95. If you cannot go

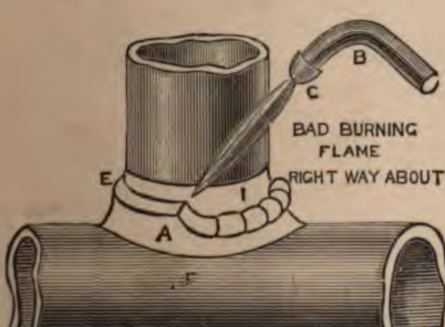


Fig. 94.

all round with the right or left hand, you must do what you can, and reverse the burning as shown at Fig. 95.

Notice the difference in these two burnings. The latter one has the appearance of good burning, while the former is rugged and not properly amalgamated to the branch pipe I. The beads only lean up against the branch in Fig. 94, whilst in Fig. 95 they are joined to the branch lead pipe.

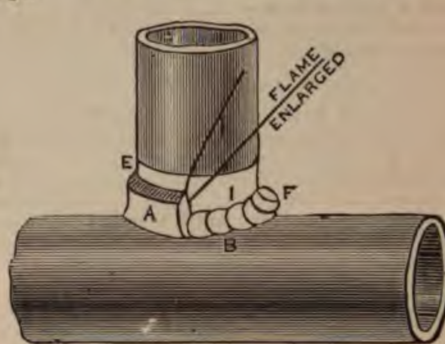


Fig. 95.

Cistern Lining and Burning.

Caution.—*Do not upon any account let your lead be fixed with the joint in the angle of cistern. For cutting the lead see Figs.* 336 *and* 337.

To line a cistern cut the lead so that the joints will stand out of the angle at least four inches, as shown at A, Fig. 96. For close tanks, such as cisterns on board ship, line the bottom and sides as you would if it were a zinc cistern, bringing the lead over the top, and nail it in the usual manner, but keep the nails as close as practicable to the out-

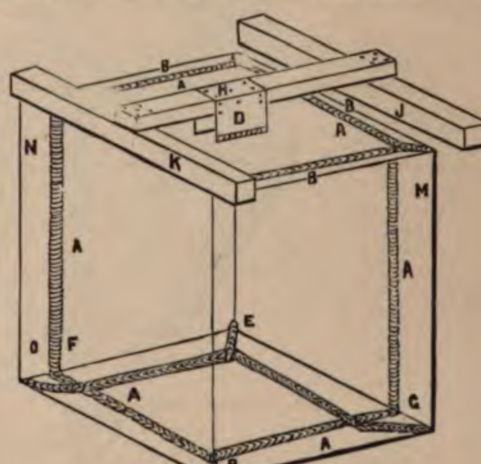


Fig. 96.

sides, or you may turn your lead over as shown at B, and burn on the top as there shown.

It is preferable to turn over the tops of the sides as though it were for an ordinary cistern, and burn the top lead thereon. The top lead must be supported with tacks as shown at D, Fig. 96, or for a small cistern the tacks can be burnt on, and placed between the joints of the top boards (which are fixed after the top has been burnt on) and then nailed, but not with nails long enough to pierce through the top lead. At first it will be difficult to burn up at the corner at E F G, Fig. 96. In this case begin with a very soft flame [as at Figs. 74 and 94], and in case you find the work smoky, be ready with a round-nosed spoon shave hook [Fig. 51], and just clean it when in the act of burning. In lining

the lead cistern be sure that the joint lead where required to be burnt up is well back against the woodwork. This answers as a backing and is much better for burning.

Before I proceed further with my plumbing, I shall, having lead burning about, give you a few lines upon chemical works work.

Chamber Work.

The lead should be as pure as possible, inasmuch as, if there are traces of tin, antimony, or other foreign metals to the extent of only three-fourths per cent., the metal is not good enough for the work. The reason is simple and palpable. When the lead is of bad quality, it will be found to contain thousands of small pin holes, and it is useless to attempt to repair such chambers, as they must always prove defective and a continual nuisance, being always out of repair.

Constructing Chambers.

This branch of the trade demands particular attention, as, where it is properly done, it is a masterpiece of plumbers' work. Fig 97 is a diagram showing a perspective view of the chamber. By referring to the bottom part, it will be seen that the lead is turned up to form a pan, as shown at A A, Fig 97. And you would naturally commence with this, because the sides overlap this bottom. Some plumbers, however, prefer to put in the bottom last; they argue that the walking about upon the lead spoils it, if done first. Personally, I fail to see why they cannot lay down boarding or something equivalent to protect it, as if it were a gutter when roofing. But be this as it may, if the bottom is put in first, it will be both easy and simple to lay the sides and corners permanently, and finish as you proceed; but if the bottom is to be burned to the sides, it is better to fix the bottom after the sides, so that the burning may be done as shown at Fig 80. The sides are sometimes hung up with straps burned on as shown at B B; then the tacks nailed to the cross-rail, as also shown. These tacks should not be more than 15in. apart; the top of the sides should be brought over the top of the crown tree, and sufficiently far over the lowest side to allow the rain-water to fall into a gutter; the side is then well nailed to the crown tree. [A further explanation as to the method of fixing the sides will be given later on.] Next the top is put on and burned to the sides, as illustrated upon the crown tree at D D. After this the top joists are put on and the top straps C C, which

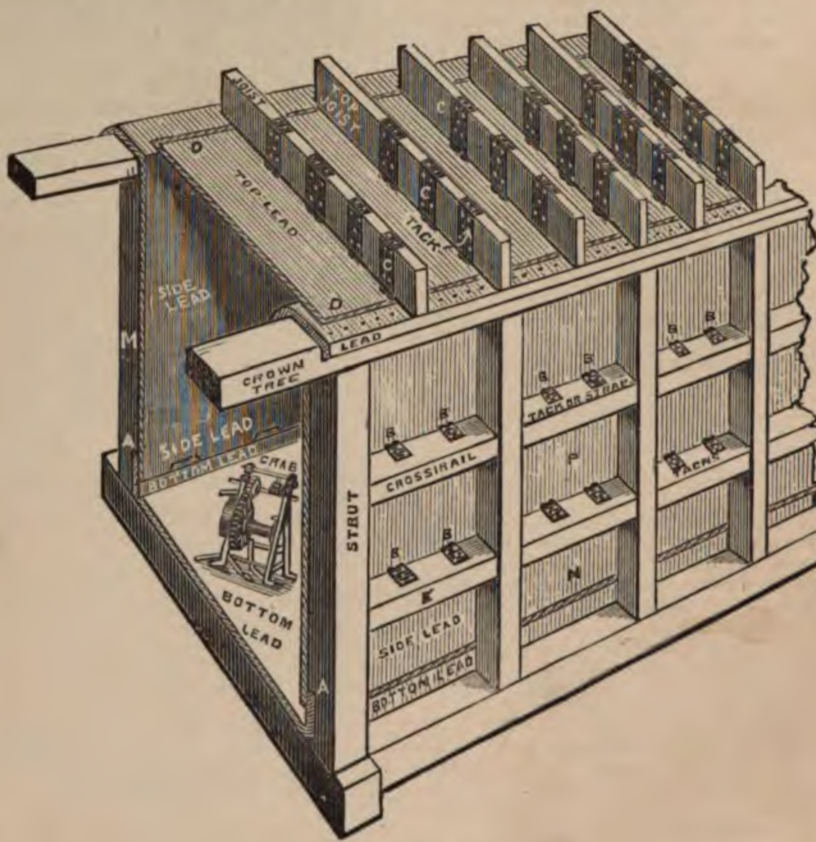


FIG. 97.

Stopping Leakages in a Chamber.

Take a piece of stiff brown paper, well covered with pitch, and dab it on the leaky spot. This will be found all that is necessary to stop it, until such time as it is convenient to repair properly.

Puttying and Stopping.

Referring to the matter of stopping leakages, I must tell my readers that the following is a first-rate stopping for lights, windows, &c., &c., viz. :—Some China clay mixed with boiled oil to the consistency of putty, which will be found to set hard and last for many years.

hold up the top lead to these top joists, as exemplified in the diagram, Fig 97, also as shown at D H, Fig 96.

Now, to examine the chamber in the course of construction, refer to Fig. 98, which illustrates the bottom, F, put in first with the sides standing up to form a tray, so that the sides may come down and dip into it to form a water the burning. Of course it will be known that flat burning can be done much quicker than upright. Now place the hoisting board flat on the bottom of the chamber, the bottom to be placed at C, C, ready for the top end to be hoisted [as shown, C, C, D, E, and H, Fig. 98].

Next lay the lead upon the hoisting board, and burn up

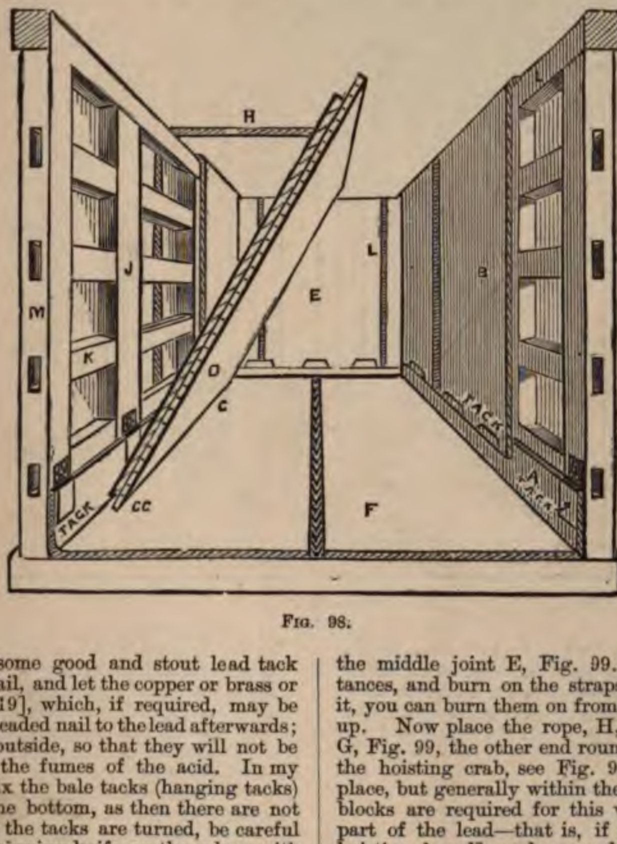


FIG. 98.

joint and seal. Next fix some good and stout lead tack [see Tack] on to the cross rail, and let the copper or brass or lead headed nail [see Fig. 19], which, if required, may be sealed over, by burning the leaded nail to the lead afterwards; these nails come over the outside, so that they will not be so readily acted upon by the fumes of the acid. In my opinion it is preferable to fix the bale tacks (hanging tacks) on the stand-up side of the bottom, as then there are not any nails required. When the tacks are turned, be careful to cut them off with the chipping knife on the splay, with the corners off.

FIG. 99.

The Hoisting Board.

To raise the sides, make a strong board about a foot longer than the lead required to be raised [as shown at B, Fig. 99, and also at D, Fig. 98]. Make the board, frame, or stage (it is known by all these names) sufficiently wide to raise two widths of lead—that is, about 15 feet. Here you can burn one seam flat, which will save a lot of time in the middle joint E, Fig. 99. Next take the exact distances, and burn on the straps, F, F, F; or, if you prefer it, you can burn them on from the outside after the lead is up. Now place the rope, H, Fig. 98, through the eyelet G, Fig. 99, the other end round the drum of the crab [for the hoisting crab, see Fig. 97], fixed at any convenient place, but generally within the chamber. Of course, proper blocks are required for this work. Turn over the bottom part of the lead—that is, if required—[as shown on the hoisting board], and proceed to hoist the side lead [as shown at Fig. 98], and fix it ready for burning, but take care to shave the edges first. The sheet for the angles should be set down square over the side of the hoisting board about 9in. In saying, "setting down" lead, I wish it to be understood that it is the very reverse of what is termed "setting up" the edges of lead when lead laying. Having all the sides fixed and the joint burned, proceed with the top. You will now require the carpenter to fix a stage or top just level with the tops of the crown tree, and as shown in the diagram Fig. 100. The top lead should be pulled up in as large pieces as can be conveniently worked; say the chamber top to be 12ft. by 60ft., in which case it is best to use four whole sheets.

Laying down the lead is very simple, as you have only to put it in its place and unroll it; afterwards burn the middle edges and round the outside edges, J, to the sides, K. This done, the next job is to get the top joist on as shown at JOIST Fig. 97. The ends of this joist rest upon the top of the crown tree, and are kept in their places from vacillating by nailing two boards along the top edges. These boards must be kept as near the ends as possible. Do not forget that you must be very particular to have one joist trimmed [see Skylight, Fig. 102]. Having the joist

on, take some straps of lead to form tacks. These tacks should be fixed every 15in., and should be at least 12in. by 6in. Some plumbers take the tacks over the joist [as shown in Fig. 97], when they do not require so many nails, and covered with lead, a little above the level of the crown tree. It is not then absolutely necessary that the joints of the tack lead should be water tight. In such work as this nails are not required, and the chamber top will last much

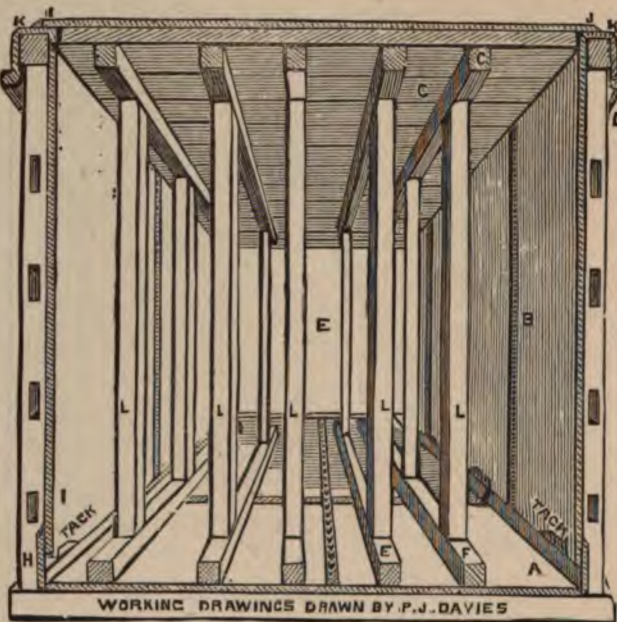


FIG. 100.

have two supports to the top lead instead of one; besides there is no danger about the nails rusting, etc. If the proprietor will go to the expense, it is far better to cover the whole of the top joist with lead, as it not only forms a

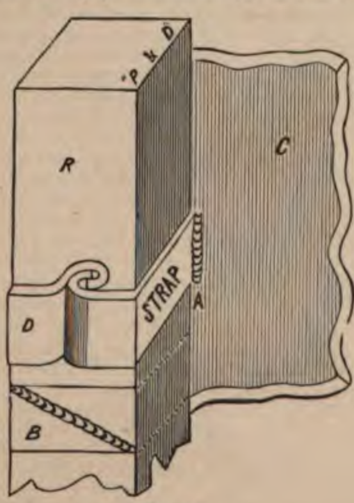


FIG. 101

better support for the top lead, but also protects the top joist from being rotted by the rain, &c. It is as well to mention here that the top joists may be raised upon blocks longer. The method of raised joist will be seen at the top of cistern at D Fig. 96.

Before closing, I must tell my readers that in some works there is an objection to tacks being fixed to the cross rails. When such is the case, the tacks are melted or burned round the struts [as shown at Fig. 101]. This is to allow the lead to expand or contract, as the case may be.

When work has to be done in the above manner, fix the burning edge of the strap or tack, A, at least half an inch away from the strut. B shows the best way to cut the tacks for burning on when not welted.

Sweating.

Instead of burning up the seams of the lead, it is sometimes sweated up, which is dreadfully hard work. It is done by first tinning the edges, and when the lead is fixed form a welt, and then with a pot of good solder splash from the top downward, about 9in. at a time, having a good heat upon the first bit, so as to soften the lead, &c. Take a large dresser and rub the welt closely together, so that as small a quantity of solder as possible may be left. This work, as compared with burning, is so exceedingly hard, that it might be fairly described as donkey work.

Fittings—Lights.

It is not my intention to describe many of the fittings, but only those in general use. Firstly examine the skylight for the chamber [see Fig. 102]. This is a simple circular leaden trough, made to a suitable size for receiving the bell glass cover. This cover dips into the liquid within the trough (water generally being used) and so forms a hydraulic joint. Be sure to cut the stand-up part, **A**, at

least two inches lower than the outer part, B, to allow the condensed acid that may collect on the bell to fall into the chamber. A large hand propagating glass as used by gardeners will answer for the bell; it is also the cheapest, though at times a simple square of glass is used. Sometimes we fix a large pane of glass into the side lead, but

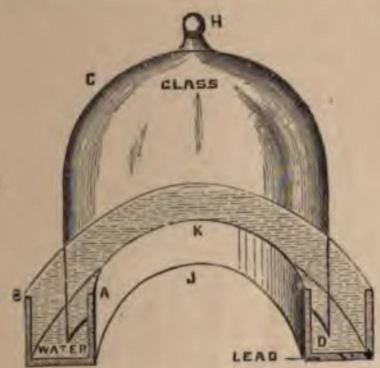


FIG. 102.

when this is done it will be found necessary to burn pieces of lead on in such a manner that they will hold the glass; the glass is set with putty, as before described. The use of these windows is to enable anyone to see the colour of the acid; they are also very handy for giving a light when repair or cleaning is necessary, &c.

Drip Trays.

This is simply a leaden tray bossed or burned up, as shown at A, Fig. 103. The tray rests upon a leaden slab,

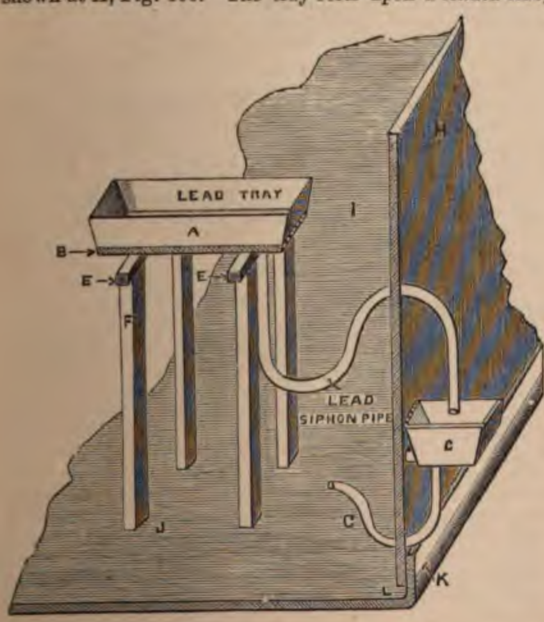


FIG. 103.

B, which is burned to the bearers E, E, these being simply pieces of quartering covered with lead and all burned together. From the tray to the outside of the chamber is fixed a leaden siphon pipe as shown. The outlet of this pipe discharges over the leaden tray, C. From this tray, C, is also another leaden siphon pipe, G, which conveys the acid back into the chamber. The use of this is to catch the condensed gas, and indicate the rapidity of condensation, together with the strength of the acid.

Siphon for Drawing Off Acid.

This diagram illustrates a siphon and boxes. The box, H, is fixed to the leg of the chamber, and by the pipe, E, connected with the tray or bottom of the chamber; then the acid will flow from the chamber to the box, H, and rise to the same level as that of the tray or bottom of the chamber, as shown at D. Then with a Wirtemberg siphon,

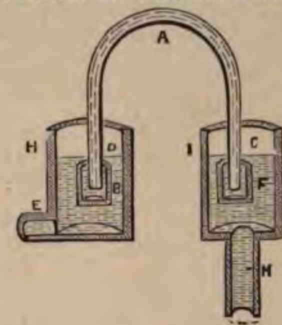


FIG. 104.

A, Fig 104 (the real Wirtemberg siphon has its legs bent up and not dipping into the cups, B, F, but this is of no consequence; the principle is the same in each case, therefore it is a Wirtemberg siphon), being charged will, when the inlet leg is immersed, cause the liquid to flow into the movable funnel or box, I, and so you are able to draw off acid at will. After seeing the illustration it would be folly to give further details.

The Siphon Starting Apparatus (known as the Siphon Setter).

The siphon setter in general use is illustrated by Fig. 105. The use of the apparatus is to draw off acid from the

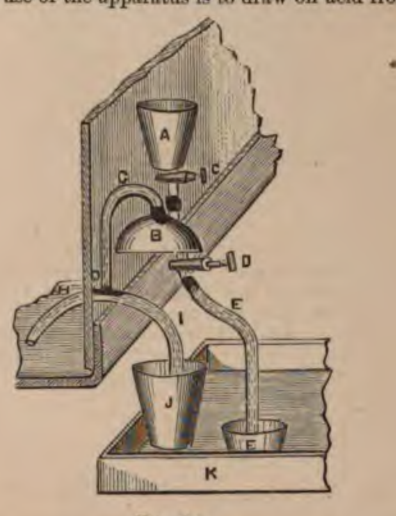


FIG. 105.

bottom of the chamber or other vessels. It is made as follows: Let H, I, be the siphon pipe to be set into action.

Branch a piece of lead pipe into the top of the siphon as shown at Q; take this pipe into the top of a close leaden vessel, as shown at B, and make the joint air-tight. On the top of the vessel B, with a leaden or india-rubber pipe and tap, C, connect another vessel, A, and from the bottom of the vessel, B, fix another pipe, E, also with a stop-cock, D. This pipe may lead over a pail or otherwise, as shown at F. All joints must be sound. To set the siphon in action with water, fill up the vessel, A, shut off the tap, D, open the tap, C, and the water will run off into the close vessel, B. Now close the tap, C, and open the tap, D, the water will run down the pipe, E, and tend to create a vacuum in the top of vessel, B; but as the pipe, G, leads from the vessel to the siphon, the suction will take place at the highest leg of the siphon, as also at the lowest leg. Now let these legs be on the same level, and the siphon pipe will be filled with acid from the bottom of the chamber and pail, J, and as long as the tap, D, remains open, so long will the siphon remain in action. Close the tap, D, and lower the leg, I, of the siphon, and the acid will continue to run, but raise the pail, J, to the level of the liquid in the chamber, and no more liquid will pass through the siphon.

Tunnels.

The tunnel is made much about the same as the chamber, the difference being its size. Fig. 106 is an illustration of one I have just made. The bottom is burned to the sides from the outside, but may be burned from the inside; the advantage of burning from the outside is the light and ease

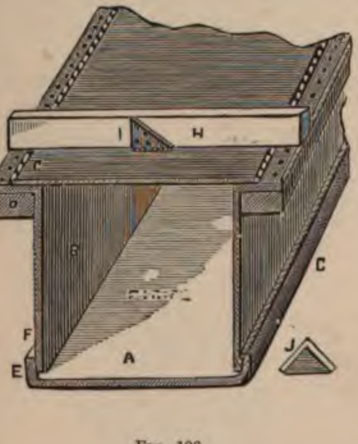


Fig. 106

with which you can work. The top is supported just the same as the top of the chamber, but the tacks do not require to be as stout, and, to save lead, may be cut diagonally, as shown at J, so that one square piece of lead will cut two tacks. The use of the tunnel is for taking the pipes through, also for conveying the fumes of sulphuric acid in large quantities, &c.

The Regulator.

The regulator illustrated by Fig. 107 is made of lead; its use is for the purpose of regulating and acquiring a uniform flow of acid under a varying pressure. I is the inlet pipe, A the store vessel, V the lead-tapering valve; this valve is actuated by the rising or falling of the FLOAT within the outlet vessel. This float, as will easily be seen, rises or falls according to the amount of the acid, and so works the beam, B, thereby actuating the valve, V, thus closing or opening the aperture, S, which keeps the head of the liquid in D at one uniform pressure above the cock, G. The bottom of the vessels, A, D, are burned on to the sides, and is too simple to require further explanation.

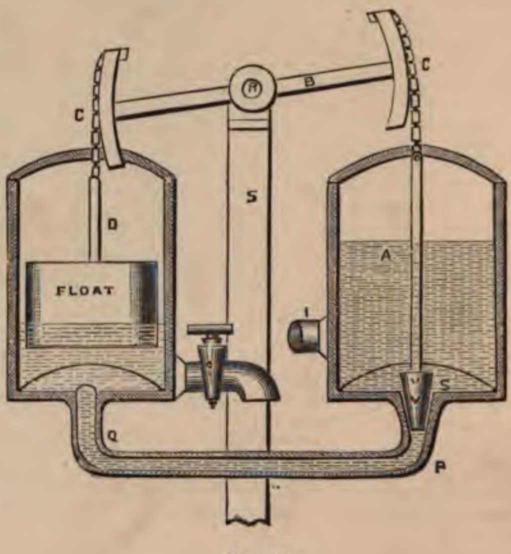


Fig. 107.

Large Lead Pipe Supporters.

Suppose you have a 2ft. 6in. pipe, and that it is required to be fixed in such a manner that it can neither bag nor flatten, the proper method for fixing such pipes is shown at Fig. 108. This is simply done by the use of

Fig. 108

staves, B, F, &c. The staves are placed round the pipe say every two or three inches apart, and are, by the use of the rings, B, B, kept in their position round the pipe. Such pipes, as before mentioned, are often suspended under the ceilings, &c. This may be done by the use of chains, &c., passed through the holes of the rings as shown at G, H, Fig. 108.

Besides the fittings that I have referred to, there are the connection pipes, steam pipes, drip lutes, caps and glasses, exit pipes, &c., &c.

JOINT MAKING.

Joint Making, Remarks on.

There are many methods of making joints on leaden pipes; one joint is good for one kind of work, whilst another kind of joint is equally good for another class of work, and the joints are known by many different names; for instance, the well-known overcast joint is in some localities known by the name of the striped joint; in another place the flange joint is known by the name of a taft joint; then there is the underhanded joint, the upright joint, the copper bit joint, the blown joint, the astragal joint, the lead joint, besides a lot of other fancy names, such as a flow joint, ribbon joint, overcast copper bit joint (which in reality is only a copper bit or blow-pipe joint). But whatever names may be given to these articles, there is no question but that a very wide difference may be made in the cost of joints suitable for the different classes of work.

Remarks on Plumbers.

To the young workman I would say, always try and select that class of joint which is most suitable for the particular class of work which he may be engaged upon irrespective of the cost, for it would be simply absurd for him to wipe a joint round a leaden gas pipe, and equally so round many caps and linings in small fittings. Then there is another thing which I have particularly noticed with some plumbers, and that is the manner in which they seem to scorn the copper bit or blown joint, and think that only quacks make such joints. Such men may be properly designated conceited quacks themselves, because these men as a rule do not know the difference between the strength of such joints, nor why they are used, and many of those who profess to know, could not tell you, when they see a copper bit or blown joint, whether it was made effectually or not. No! they think that a wiped joint must of necessity be the acme joint for every purpose, and generally, these men take a pride in learning to make a wiped joint which, when finished, shall be as smooth as glass, often making them five or six times over, while, in reality, the joint first made is equally as serviceable as the one which they make after probably a useless hour has been spent upon the finished one. Of course I like to see clean, good work. Generally, such men make a hard and fast rule of wiping every joint, and could not for the life of them do anything else; and I contend that when such men are thus so bigoted over simple joint making that they often make their work cost five or six times as much as it should do, then I say that it is no wonder that an employer should, at the sight of a plumber, grumble as soon as he enters the house, because these fancy joint-making plumbers make so much fuss in doing a little repairing job (for argument's sake, repairing a broken pipe) that the whole of the house is often discommoded by their presence; whereas another, and, in nine cases out of ten, a much better workman, though not so fussy over his joints, will enter the house, do his work, and nobody knows that he is in the house. These are minor points, which are by some plumbers too often overlooked. And what is the consequence? They positively drive the employers into another channel to get their work done, and the consequence is that a gas-fitter is invariably the person who is asked about this, that, or the other, and he with his blow-pipe or copper-bit immediately sets to and in a jiffey repairs a leaden pipe, and from such like little things the gas-fitter becomes the favourite man, and in this way we lose our work, often the masters not knowing the reason.

It should by all be remembered that the favourite workman, whether it be with employers, architects, or builders, is always the man most polite, tidy, regular in his work, and obliging, and such men as a rule nearly always oust the uncouth and slovenly workman, though the latter may be of the A1 class.

After this illustration of the joint-making business, I will proceed to instruct you in the various methods of joint-making.

The Saw.

Having with a panel toothed saw (about 15in. to 18in. long in the blade), cut your leaden pipe square across, proceed to open one end as follows:

The Turnpin.

This tool [Fig. 109, also shown at G, Fig. 12], should be made of hard wood, box by preference. It must be turned quite true and cone shaped, if large for soil pipe, pump work, &c., tapering from 6in. or 8in. at one end to 2in. or 3in. at the other, and about 1ft. in length. This tool is used to open the ends of soil and other pipes. Of course smaller ones, varying from 3in. to 1in. in diameter, and from 6in. to 1½in. long, are also required. The best shaped turnpins for taft joints, copper bit, or blowed joint

FIG. 109.

work, are those tapering from 2in. to a ¼in., and whose length does not exceed 3in. Small turnpins for this work have their taper to the above scale. If the outer edge of the turnpin has its tapering edges rounding something after the shape of the lines of the plumbob as at D B, Fig. 18, the turnpin will work easier, and will not jamb itself into the pipe, and the pipe will be all the better when opened for making the joint; but for wiped joint work, the turnpin taper should not be so sharp. A handy size for general work is 2½in. across the top, to ½in. at its point, with a length of 4in., but for my part I prefer them made as follows: For opening pipes from ½in. to 1¼in., the top to be 2in., point ¼in., length 6in. For 1½in. pipe to 2½in., the top to be 3½in., the point 1¼in., length 6in. These turnpins should have their tapering edges a little rounded as before, when they will be not so apt to jamb. The above two sizes will bring you up to your soil pipe turnpin, which should be 7in. across top, 3in. at bottom, and 10in. to 12in. long.

Opening the Ends of Pipes for Soldering.

First with your knife take off the rough or gaggy bits from the inside of your pipe; then select the turnpin

suitable for your work; first wet it with water, spittle, or otherwise, and place it in the pipe as shown at Fig. 110, the first finger and thumb of the left hand clipping near

Fig. 110.

the top of the turnpin, whilst the lower part of the palm of the hand, and the two, or sometimes three fingers clip the pipe (of course this is for work of ½in. up to 1in.). Now, having the turnpin in the pipe, as illustrated, take your mallet and strike the turnpin fair on its centre, occasionally loosening it by a side tap with the mallet, taking care to keep the turnpin wet. Should the turnpin run out, *i.e.*, should the side of the pipe become a little bulged or lopsided, then strike the turnpin on the side opposite, which will bring the pipe to its proper shape.

Fig. 112.

Fig. 111.

You may find your pipe inclined to split; if so, with the mallet beat the edge of your pipe so as to *thicken* it [also see Opening Pipes for Flanged Joints], and by this means you can open the pipe to almost any desired width. Some pipes will split no matter however careful you may be in driving the turnpin in. The cause is due to the fact that the bridge of the centre die or mandrel is too close to the bottom of the cylinder, or that the lead is pressed too cold; the bridge seems to split the lead, which never properly gets joined when the pipe is being pressed from the cylinder. Next examine Fig. 111, which illustrates the pipe after it has been opened suitable (say ¼in. wider than the pipe) for a blown or copper bit joint. If for a copper bit joint, it will not require soiling. The next tool you require is the shave hook [see Fig. 50]. Now clean the internal part of the joint all round the part required for soldering, and 'touch'' (tallow candle is known as touch; some plumbers use composite candles for touching their prepared lead with before making the joint, but I do not like it, as it stinks too much when soldering, and stuff which is mixed up in this candle spoils the metal) it over ready for soldering, or this cleaning may be done with a pocket knife. Caution.—Don't let the shavings go into the pipe.

Rasping Pipe Ends.

[*For the Rasp, see Figs.* 176 *and* 177.]

Next is the male part. Rasp the edge J [Fig. 111], true, then rasp the end tapering and as shown at F J. Before I proceed further, I had better say a few words on the importance of rasping the ends of pipes. This is of more importance than may be supposed, for if the end is not truly rasped to a nice taper it cannot be expected to fit, and consequently the joint will, in all probability allow the solder to run inside (which is too often found in pipes). To do this rasping off properly, take the rasp and pipe as shown at P Fig. 113; catch hold of the handle of the rasp, but not the rasp itself, as shown at R in the diagram (I have shown it done here, because it is the plan generally adopted by learners), and rasp the end down to the inside pipe line, and at an easy angle, as shown at Q R Fig. 113,

Fig. 113.

also at J F, Fig. 111. Always rasp the pipe with the rasp cutting against the end, so that you can see the sharp internal edge. When the pipe is required to be rasped from the floor upwards, hold the rasp back-handed, as shown at M, for when the pipe is upright and about breast high you can work the rasp much easier and better. If you hold the pipe as shown with the side of the palm upwards, you will not be so likely to rasp a lump off your first knuckle or thumb.

Shaving.

Next is the shaving. Let us suppose that E F, Fig. 111, or E E, Fig. 124, is the line to be shaved. This first figure is for the copper bit joint. Copper bit joints may be roughly shaved, but must be thoroughly clean all round, otherwise that part not shaved cannot, if soiled, become tinned, and the joint will leak).

Shaving Ends of Pipes.

This is done as at Fig. 114. It may be learned in a few days. First practise with a short piece of pipe as follows: Lay it on the bench and with the side of the blade of the shave hook mark it all round so as to form a *perfect* ring as shown at E F, Fig. 111. This is done by catching hold of the shave hook as shown at H, Fig. 114. Let the forefinger go quite up against the blade; this gives you more power over the hook and steadies it whilst working or shaving round the pipe. Now, having learnt how to mark it round *truly*, next begin to shave it. This is done by holding the shave hook with a firm hand, but not necessarily heavy, and at such an angle to the pipe that you can cut a shaving off without "rivelling," or causing the same to have a wavy or notched appearance. Sometimes you can do the shaving more expeditiously by placing the front of the left hand forefinger as a guide for the blade of the shave hook—that is, by holding the pipe in the left hand, with the forefinger at the guage line for the back part of the blade of the shave hook to come up to, or at other times the left hand thumb nail will answer for this guage line; or if you are careful you may form a guage for the second stroke by placing the blade of the hook carefully against the notch of the last shaving line, but do not

Fig. 114.

dig the notch deeper than is necessary for the shaving. The shaving line should be perfectly true, and not like so many irregular teeth to grin at you after the joint is made. When the pipe is upright, and about breast high, the shave hook, generally speaking, can be best held back-handed—that is, by putting the blade part of the hook towards the fleshy part of the palm of your hand, and the thumb on the top of the handle.

Tinning Brass, Copper, and Iron Pipes, &c.

All pipes and other brass, copper, and iron work must be properly tinned at the joint before you can proceed to fix it in connection with lead for soldering. Copper or brass may be tinned with resin or killed spirits of salts. Iron should be tinned with killed spirit, though with great care it may be tinned with resin; the solder must be good for this purpose.

Fixing Joints (Upright).

There are scores of places where you must invent a method for fixing your work for soldering. Fig. 115 illustrates the pipe fixed for an upright joint. It is done by driving two or more fixing chisels into the brick or wood-work, as shown at J H, E being the back part of the joint, which must be fixed far enough from the wall, &c., to get a small ladle behind. With string tie the pipe firmly to these

Fig. 115.

chisels, as shown at A, B. Now put your hand to the pipe as shown, and try it for firmness by gentle pressure; also try if you can get your ladle round the back part of the joint. If the joint be in the least degree shaky fix it so that it is not so, by using another chisel, or as best you can. N.B.—Never fix the top pipe to go outside the bottom pipe, but always let the top enter the bottom length, as then the solder will fill up the space around the joints properly.

Chisels (Fixing).

These are best made with long taper sharp points like the tang of a round file. In fact, a 12-inch or 15-inch rat-tail file softened down will make an excellent fixing chisel. For fixing the collar to catch the solder see Fig. 125 and description.

Cramp or Joint for holding Upright Joints.

This is illustrated at Fig. 116. This is a tool which the

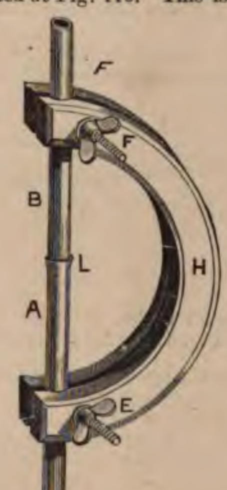


Fig. 116.

plumber can easily make, and one should be in every plumber's shop, as it can be fixed in a vice and saves a lot of trouble in fixing work, such as bosses, union linings, cocks, valves, pipes, &c., whilst the joint is being made. Also see Boss and Union Holder.

Making Copper Bit and Blown Joints.

Having prepared your joint as directed, and fixed it as at L, Fig. 116, with a space between the flanged part of the bottom pipe for, say, about ⅛in. of solder, next see about soldering it. The first thing required is a hatchet-bit. This tool is illustrated at Fig. 4, also at L, Fig. 12; but if you have no hatchet bit you can do the work with a bent one having its point bent round to get behind the pipe, or a straight-nosed one may answer, as illustrated at Fig. 5, &c.; but this tool will not be found so handy to get round the back parts or for awkward places. Of course the face of the iron must be sharpened to a suitable shape for the work, the best shape being a V, as illustrated at L, Fig. 12, or, to make this plainer, to the shape shown at the point of the sash-weight pattern, Fig. 14. The nose of the iron should be brought to a point of about ¼in., so that it may get at, and if necessary, *into*, the solder, in order to heat and tin both sides of the lead at once, and *all round the joint*. The face must be well tinned about ½in. up and on both sides. Now put some pounded black resin [see Pounded Resin] round the joint, and with a *clean-nosed*, bright, tinned-faced iron melt a little solder all around, taking care not to have the least dirt in your work or resin. Having melted sufficient solder to fill in around your joint, run the nose of your iron well into the solder (hence the reason for having the point of the iron this shape), *and well tin your lead;* also float the solder round the joint, which is done by drawing your iron (when well hot) steadily round from one side to the other; the joint should be left as smooth as any part of the lead, as shown at E F, Fig. 112, which is done by having sufficient heat in your iron to cause the solder to flow freely. After all is done, if you have made much mess with the resin, take some touch and rub over your joint, or the dirty part; this, if done when the resin is hot, will soften same, and you can wipe all away with a small piece of rag.

Blown Joints and Blow Pipe.

[*Also see Lamp*, Fig. 153.]

A blown joint is made in a similar manner, excepting that in place of an iron you use a blow-pipe and gas or

Fig. 117.

rushes to melt your solder, which can be done with a very little practice. Fig. 117 is the general shape of blow-pipe used.

When blowing a joint use fine blow-pipe solder. This should not exceed ⅛in. in thickness, or it will take too much heat to melt off sufficient solder. Begin by first putting a little powdered resin round your joint, then take the rushes in the left hand, and your blow-pipe in the right; the rushes should be wrapped in brown paper for handling them without greasing your hand. Now light them, and with your blow-pipe begin blowing the flame on the parts of the lead to get up a sufficient heat to melt the solder, *but not the lead.* When the heat is nearly up, put a little more resin on and touch the joint with the solder, and add more fire to assist in melting off some solder. Keep at this until you find just sufficient heat to cause the lot of solder to flow and unite with the lead; then the joint is made. Of course you must use every care not to get the solder through into the pipe. After the solder is just set, rub the rushes round the joint, and with a piece of rag wipe it clean. This grease softens the resin, and allows it to come away, leaving the joint nice and clean. Some plumbers use a jet of gas, or at other times a small spirit-lamp—there are scores in the market. Cotton and Johnson's people can always supply you with such articles [see Fig. 153].

Easy Fusible Alloys.

[*Also see Solder Table.*]

Lead, tin, bismuth, mercury, and cadium.

Boss or Lining Stick.

This is simply a piece of wood cut with its end taper, and to a shape suitable for driving into a boss for holding it

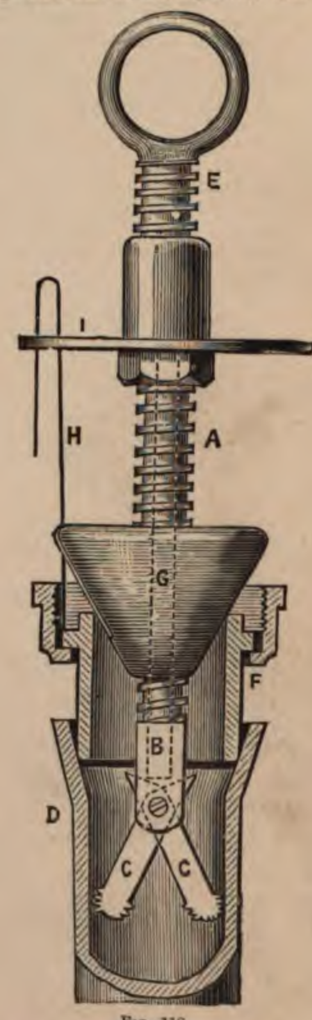


Fig. 118.

to the end of a pipe whilst soldering [*see* STICK, Fig. 129]

Caution.—When driving the boss stick into linings be

careful not to force open the projecting horn or top end of the lining, or you will find it too large to enter its place when required to be screwed up. The projecting top end of the lining spoken of is shown where the cone enters the lining in Fig. 118 and above F.

Boss and Lining Holders.

Sometimes a quantity of spills or splints are cut about 6in. to 8in. long, and pushed firmly into the boss, say 4in. through, and then the ends into the pipe, which will keep the boss steady.

On referring to Fig. 118 it will be seen that the levers G G are fixed in a line with flange I, so that in making a cross joint, the flange I stands across the pipe; the boss, or union F, is placed over the levers G G, the conical piece G is then screwed up or down, so as to let the levers G G show through a little more than half the hole of the pipe—that is, in a 1in. pipe shown through a $\frac{5}{8}$ of an inch; by so doing the levers G G will take hold of the inside of the pipe at the widest part. The spring H is provided to hold the nut of the lining up in its place, and a row of holes in the flange I to suit the different sizes of the cap. In the event of the cap being too small to allow the spring H to pass over the conical piece G, a stolway is provided, which can be brought round under the row of holes so that the spring may pass through. In making a joint on a boss or union, at the end or side of a pipe, the same need only be opened to the size of the inside of the boss, or other piece to be soldered, as the holder will hold the same butted. The nut F, Fig. 118, can be held up by opening a piece of twine and slipping the lining through, then bringing the two ends of the twine up and round the lining stick as at A, Fig. 118, when it can be tied, which will hold up the nut from the joint whilst being made.

Wiped Joints (Preparation of).

By the apprentice these joints are not so easily made as with the copper bit, but with practice you will soon get over the difficulty. In the first place you will prepare the male end as you did for the copper-bit joint, excepting the shaving, which must be longer, and the outside pipe will not require to be opened quite so wide as before, but as shown in section at K, Fig. 120. Here you see that the male and female ends are rasped off. This is in order that you may have a little more solder around the joint without extending the size of same.

The Soiling.

Now having all cut and fitted, you will require the ends of the pipes clean, and free from grease or oil [for this see Soiling Soil Pipes, &c.]. This is done by rubbing a little chalk, whitening, ashes, card-wire, or glass-paper over same, and well rub it off with an old felt or anything else. Next the soil smudge or tarnish is a very important thing in wiped joints, especially to the novice. For soil making, see Soil Tarnish, &c.

When putting it on it must be straight, and without daubing your work all over. Cut the edge true, for nothing looks worse than slovenly soiling. Soil your joints from 3in. to 5in. past the solder line. Upright joints require a longer soiling than underhanded joints.

Joints (Considered.)

Having all your work prepared, fix the joint together as shown at the section, Fig. 120, which is a round joint to be made either upright or underhanded. You see at K that the male fits but a little recess is left for the solder to get into. Many plumbers close this; they cannot do a worse thing, as it is very useful in joint-making. At Figs. 121 and 122, you see diagrams of long and short made joints; this is how the joints should appear when finished. Fig. 121 is a short and Fig. 122 is a long joint. On examining the section, Fig. 120, you will notice the dotted lines H I, which shows the outer line of the solder on the long joint, and F N, the outer line of the small joint. The small joint does not take the amount of solder of the large joint, and on further examining same across the centre of joint at D, you will perceive an equal thickness of solder; therefore the joints are equally strong across the actual joint. There is one advantage with the long joint, it is easier to make, because you have a larger quantity of solder to play with, and which retains the heat, and also for small joints you are enabled to use a larger cloth; its length also renders it less liable to show imperfections as to roundness, &c. The large joint should be first practised upon, and then try to reduce same, keeping in mind that the centre thickness of solder is the principal point to watch. The substance of solder is generally about twice the substance of the lead at that point, not merely for strength, but for other purposes to be explained. Every plumber should know that solder is much stronger than lead, taking it bulk for bulk; still this thickness cannot be made the rule, inasmuch as some waters are chalybeate or impregnated with iron, &c., which readily attacks the metals composing the solder; in such cases you must use discretion as to the substance of metal around your joint.

Shaving for Wiped Joints

I have before referred to shaving end of pipes, but as the appearance of the joint much depends upon the shaving, I will give you the lengths of shaving for two or three different sized pipes. The inside pipe should be rasped off as at B D, Fig. 144, $\frac{1}{2}$in. in length from outside edge to the inside edge of the pipe. This is known as long rasping off, and is much the best, and makes better work; it is well illustrated at J, Fig. 120. Now (or at least until you have learnt your shaving lengths) place the ends one into the other so as to form an easy continuous line of pipe, and mark the shaving. For a $\frac{1}{2}$in. joint the shaving, for easy and good looking wiping, should be $2\frac{1}{2}$in. long; for $\frac{3}{4}$in pipe $2\frac{3}{4}$in. long; for 1in. pipe, 3in. shaving makes a middling long joint, but most London plumbers shave the joint $3\frac{1}{4}$in. long; this makes a good looking joint, and to some plumbers is easier to wipe. Also shave $1\frac{1}{4}$in. pipe $3\frac{1}{4}$in. long, $1\frac{1}{2}$in. or 2in. pipe from $3\frac{1}{4}$in. to 4in., 3in. pipe $3\frac{1}{2}$in. long to 4in., 4in. pipe ditto, 5in. pipe $3\frac{3}{4}$in. to 4in., 6in. pipe 4in. long, all others above may be shaved 4in. E, Fig. 124, and E F, Fig. 144, illustrate the shaving line on the male end, which on account of its entering the female, say $\frac{1}{2}$in., should be shaved this much longer [see the section from H P to I G, Fig. 120]. For soil pipes let the male end enter 1in. or more, shave the joint 3in., or more, or if you require a long joint, from $3\frac{1}{4}$in. to 4in., as you like, but 3in. work has a very good appearance if a fair amount of solder be used, so as not to make it too bulky nor too "skinny." At Fig. 340, on the left hand side of the barrel drain, may be seen a light or "skinny" joint, but on the right hand side may be seen a very good plump-looking joint.

Pouring Stick.

This is only a piece of deal $1\frac{1}{2}$in. by $\frac{3}{4}$in., about 10in. to 12in. long, and having a groove cut 1in. wide, and $\frac{3}{8}$in. to $\frac{1}{2}$in. down the centre, from near the handle part, for, say 6in. up. The bottom part is shaped like a scoop. The use of the pouring stick is for places awkward to get at; also for cisterns. I have seen them used for trap-work, but think very little of it.

The Splash-Stick.

This is made of wood, about 6in. long, 1¼in. wide, ⅛in. to ¼in. thick, shaped for holding. Some use iron, but I do not like it, as you are apt to scratch the soil off the lead, though iron is best when solder is used very hot, as the wood then gets burnt and smokes.

The Cloths.

I do not know any tool more important than a good cloth, and nearly all our best plumbers pride themselves upon keeping a good clean stock. It should be made as follows:—Take a piece of new moleskin or fustian (the former is the best) of moderate thickness, for ½in. joint, 12in. long by 9in. wide, then fold it up one side 4in.; then 4in. again, and again 4in.; then fold it in the middle, which will make your cloth 4in. by 4½in., and six thicknesses thick. This is suitable for ½in. or ¾in. underhand joints. (Some plumbers prefer a thin cloth; they like to feel the metal, *also the heat*, but with a thick cloth you can wipe truer). After this is done, sew up the ragged ends to keep it from opening. Then melt a little tallow (only just melt it, not boil it to burn your cloth, as many do), and pour a little on one side, and the cloth is ready for work. Keep to this side, occasionally rubbing a little touch on this face side. If the cloth is too rough, rub a little chalk upon the face. The use of the tallow is to prevent the solder from sticking to or burning the cloth. It also makes the solder work smoothly. Some plumbers, after the cloth has been in use for a considerable time, take them to pieces and wash in hot soapsuds and soap to clear the dirt and make them soft. Bed ticking is used by some plumbers; in fact, I used to use this myself, but discarded it when I saw the better materials used; some plumbers pin their cloths together, but if the cloth is sewn it works firmer and better.

P. J. Davies' Cloth Table for Different Kinds of Cloths.

This Table is for a moderate thickness of material: if very thick, one thickness less. *Underhand* "to be made as before."

Pipe.	Size of Cloth.	Thicknesses.	Remarks.
Diameter in Inches.	Inches.		
½ to ¾	4 × 4½	6	After 2½-in. use two cloths, the ¾-in. for finishing, and the large one for getting up the heat.
1	4½ × 4¾	8	
1¼ and 1½	4¾ × 5	8	
2, 2½, and 3	5 × 6	8	
3½, 4, and 4½	6½ × 8	9	
5 and 6	9½ × 10	10	

Branch and Upright.

Pipe.	Size of Cloth.	Thicknesses.	Remarks.
Diameter in Inches.	Inches.		
½	1¾ × 2¼	6	Some prefer a size larger, but the smaller the better, in some cases.
¾	2 × 2½	6	
1	2½ × 2¾	8	
1½ and 2	2½ × 3¼	8 to 10	
2 and 6	3 × 3½	10	

Cistern Cloth.

2½in. × 3in. | 8 to 10.

Traps and Odds and Ends.

2½in. × 2in. | 6, or the ¾ cloth.

Sew the 5in. and 6in. cloths all round, and from corner to corner diagonally. When working 12in. to 18in. joints underhanded, larger cloths are required, and are worked two-handed, or by *two plumbers*. Before you begin to wipe your joint, stop the ends of the pipes to prevent draught, which will make a very great difference when you are at work with the metal.

Collars, or Solder Catchers.

Suppose you have your joint upright as at Fig. 125, you will require something to catch your metal (solder); then if you have a piece of sheet lead handy, cut a collar, which is generally made by cutting it round or otherwise with a hole in the centre the size of the pipe; if too large, pack some newspaper between the collar and pipe. To put the collar on, a cut from the outside to the hole is made, which enables you to slip the collar over the pipe. Before fixing it well soil same, and tie a piece of string round the pipe as shown at Fig. 125, which will support the collar and prevent the solder running through; to support the outside part of the collar, tie your compasses as shown at M N, and the ends of the compasses will act as props, but if no compasses to hand two pieces of stick tied across the pipe, or an iron chisel or screwdriver driven into the wall, &c., will answer; or the ends of the collar may be cut to come to a long point, which will allow for the ends to lap over, and so form a kind of tie to keep the collar together; this should always be done, even though props are used. The collar should be put on as shown at F G, as level as possible, as it is much better for parting your solder round the bottom. When fixed as at DE, the solder drops down and sets round the bottom, and is at times very difficult to remove without the iron, as it cools much quicker when in a small body.

Joint Wiping, Upright.

Before you begin to wipe your joint stop the ends of your pipes to prevent draughts. "The metal's hot—bring it!" is the cry. During this time you should select your cloth. In this case, for a 1in. upright joint, the size is 2½in. by 2¾in. The metal's here: you give your cloth to the mate, who will get the face side warm by holding it over the metal-pot (or, if you can trust him, he will get your cloth for you and bring it ready warm). Take a felt, that is a piece of old carpet, 9in. long or so, to hold your ladle with, then take your ladle full of solder and set to splashing your metal on the joint with the splash-stick as shown at H, I, J, K, L, Fig. 125, taking care not to burn the pipe with the solder, that is, by splashing too much in one place; look sharp and get up your heat by getting on as much solder as you want, and as near the shape as possible. Keep it alive by working it up with the splash-stick. If it drops down push it up again with the stick, warm it up with fresh metal, keep at it until you have the joint to look as at I, J, K, L; now take another ladle of hot metal and splash it up the soiling about and round B. To get a little more heat on your lead, keep splashing and patting it up to the proper shape with your splash-stick. It is just hot enough; now take your cloth, well hot on the face side, in the left hand, and with a sharp sweep wipe quickly and clean round the top and back part of the left-hand side of your joint, then the bottom, next the centre; change hands and do the other side, that is, round I K, and finish by wiping down from B to H, and from H to K L, and your joint is done Whilst hot, part your metal so that it will leave the pipe. You at first will require an iron for this work, but keep practising until you can do it without. Pray work away at this, until such times as you can wipe off without an iron, as you will do

better hereafter. The time required to make this joint is about one and a-half minutes, that is, getting up your heat and wiping included. The wiping alone should not exceed 20 seconds.

Tin-running Phenomena in Joint Making.

Why did I recommend you to wipe round the top of your joint first? This may seem a peculiar question, but one which you should now be able to answer, for, however difficult it might appear, it, nevertheless, is very simple, which can be reasoned out as follows:—The tin being easier to melt than the lead naturally is always, when in the state of solder, kept in a more fluid condition, and by your continually piling on the solder around the top part of your joint, the lead by preference hangs or sticks up, whilst the more fluid particles of the solder naturally fall to the lower part; the consequence is that the solder round the top part of the joint becomes coarser, and consequently sets quicker than that round the bottom, and should be wiped first. This may be often noticed by examining your joints after you have wiped them, as you will often find the joint to be bright, and often little teats, as at L, Fig. 125, or even a little fine bright bead may be seen at this lower part of the joint. Another reason is that the surplus solder round the bottom always tends to keep that part of the joint hot.

FIG. 119.

FIG. 120.

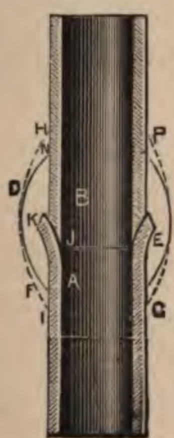


FIG. 121.

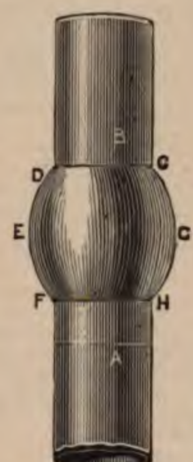


FIG 122.

FIG. 123.

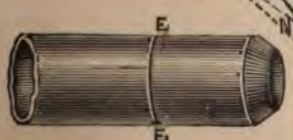


FIG. 124.

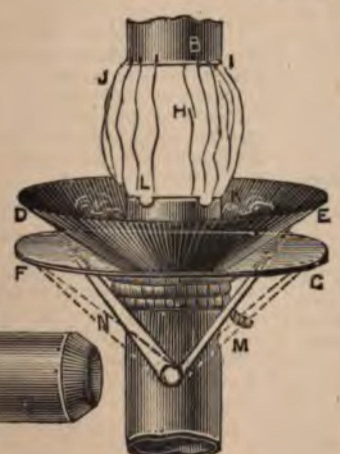


FIG. 125.

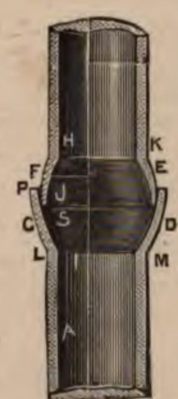


FIG. 126.

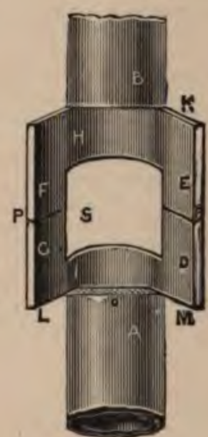


FIG. 127

Overcasting.

[For this, see Fig. 123]. This work may be done when you are afraid that your joint is not sound. Sometimes learners adopt this style so as to make sure of their work. It is also very handy to be able to glaze a joint used for hot water, but I should say that in London you will not require to overcast your joints, as was the custom in the time of the old architect, Vitruvius, a hundred years before Christ, but when in the country you may—that is to say, when your solder has to be used very coarse. This overcasting is done as follows: Suppose your solder to be four of lead and one of tin, the solder would set quickly and be very porous; then you will want an iron to warm or liven up your solder. The same iron will do your overcasting, as follows: Having

shaped your joint, well touch the same; take the handle part of the ball of the iron, and rub it from bottom to top of the joint, as from G to P and Q, Fig. 123, just to glaze the joint; then bring it down again the same way; this gives the glazed or ribbed line, which should not exceed half an inch in width. Next do H, taking care to let the outer line cut the glaze of G; next do I, J: begin at the other side and bring round as at L, M, N, O, and finish at K; or if you want it to look even all round, begin at one place and go all round until you come to where you began, keeping an eye to your ribbed lines.

Fixing Joints and Bosses on the Floor.

It often happens that you will have to make shift in fixing your work on the floor; you can easily get a good fixing for underhanded joints as shown at Fig. 130, where the pipe is fixed upon two or more blocks, bricks, &c., as also shown at A, B, Fig. 129. Here K is the lead pipe, D a piece of square stick rounded to a very easy taper, and firmly driven into the boss, G. The pipe is prepared and laid in a horizontal position, and the boss fixed as shown. NOTICE that the front of the brick is tilted at B off the floor. This is a capital plan for keeping the boss pressed forward into the lead pipe. With a coil of pipe, or otherwise, weight down the boss and pipe as best you can. Sometimes it will be necessary to have four bricks, which, if you are at work on a building, is no trouble to find, and when in the shop at work use the soil pipe blocks, if nothing better be at hand.

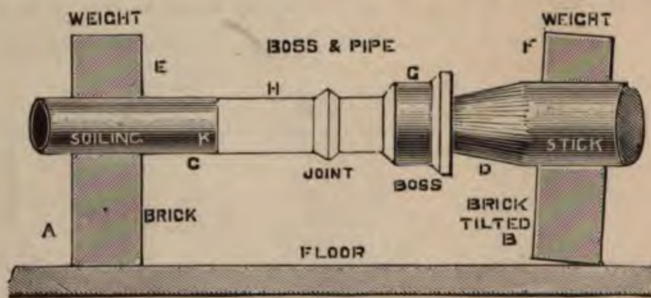


FIG. 129.

Internal "Joint-Wiping."

In some cases when upright or underhanded joints are required to be made, it will be found impracticable to wipe round the back of the pipe; for instance, suppose you want to wipe a 4-inch joint round a pipe which was lying within half an inch of a ceiling or wall, it would be impossible for you to get your hand round. In this case prepare your joint as at Figs. 126 and 127, so that you may wipe half from the inside, as at S, Fig. 127, which is done by cutting the pipe in front and opening same; of course you must work your pipe outward at the joint, as at K, E, D, M, Fig. 126, to wipe your solder flush with the inside of the pipe. H, I, shows the soiling, and E, F, G, D, the lead laid open, P, P, the centre of the joint or lead.

Having wiped the inside, either close the opening with the lead E, F, G, D, or, as is much the best, let a fresh piece in, and wipe it there, as shown at N, K, P, Fig. 119. When practical, use a short mandrel. When fixing the door part, N, K, P, Fig. 119, be sure to have the water-way free from rough edges.

Underhanded Joints.

These joints are shown made, and as they should be finished, at Figs. 121 and 122. You prepare the ends as you did for the upright joints, and as shown at section K, E, Fig. 120, and also shown at A, B, D, in the elevation, Fig. 128.

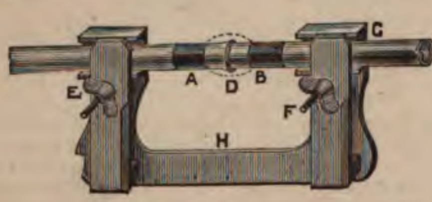


FIG. 128.

Here you see the pipe prepared, and the joint fixed in a plumber's clamp ready for soldering. [*See* Fig. 130.]

Fixing Underhanded Joints on the Floor with Chisels.

If neither bricks nor blocks be to hand, drive fixing chisels into the floor, and fix the joint as shown at Fig. 115, but horizontally instead of upright.

This joint illustrates the effect of opening the lead with a badly-shaped turnpin; it is too sudden, and swells the outer edge abruptly. The rasping off is also done too short; it should be as that shown at K, E, Fig. 120.

Making Underhanded Joints.

[*See* Fig. 130.]

First place a small piece of paper under the joint to catch the surplus solder, and begin soldering as follows:

FIG. 130.

Take the felt in your right hand, and with it hold the ladle three parts full of solder. To see that it is not too hot, hold

the back of your hand within two inches or so of the solder. If it *quickly* burns your hand it is too hot; if you can only just hold your hand this distance away without pain, use it; but if you cannot feel the heat, it is too cold. This is soon known by a little practice. Another test is to take a little piece of newspaper and immerse it below the metal; if it blazes instantly it is too hot; if it browns quickly without burning, use it. When you begin to pour your solder upon the joint, do it very lightly, and not too much on at a time in one place; but keep the ladle moving backwards and forwards, pouring from E to J, Fig. 130, first on one side of the joint to the other, and from end to end; also an inch or two up the soiling, as shown at E, Fig. 130, on purpose to make the pipe nice and hot, and to the same heat as the solder. The further in reason the heat is run or taken along the pipe, the better chance you will have of making your joint; hence one reason for the long joint, as was shown at Fig. 122. Keep pouring away, and with your left hand hold the cloth, C, to catch the solder, and so cause the same to tin the bottom of the joint (especially looking after this point in large joints), and to prevent the solder from dropping down.

NOTICE.—The cloth is shown at Fig. 131 as it should be held when tinning the bottom of the joint; it is somewhat bulged or bagged. Having a small quantity of semi-fluid

FIG. 131.

metal in your cloth, begin to work it about the bottom of the joint, and up the sides.

Here the cloth is well illustrated, at Fig. 132. It shows it being worked up from the bottom towards the top, which should bring a portion of the metal with it. Keep pouring on

FIG. 132.

fresh metal, moving your ladle and cloth from side to side, and by degrees get the solder nice and soft; and as the metal begins to feel shaped, firm and bulky, get the shape as near as possible, taking care to have it all soft, and when it is in this shape and in a half semi-fluid setting condition, quickly *put the ladle down* and do not stop a second for anything, but with your left hand shape this side of your joint, always beginning at the outsides, or at that part next the soiling; then take your cloth in the right hand and do this side, *finishing on the top;* then, if you have a small joint, say, up to 2in., and have been quick with your solder, it will not be set; then give the cloth a light run all round your joint, and this will make it look like a turned joint. If it is not quite clean rub a little touch round it and wipe it with a piece of clean rag, or a damp sponge will answer instead of the touch and rag.

Some plumbers, after they have shaped the joint roughly bulge the cloth [as shown at J, Fig. 133, as held for wiping a rolled, and also upright joints], and wipe or finish off the joint.

FIG. 133.

After a little practice you will be able to wipe your joint without shifting your cloth from one hand into the other. Allow me to say that the secret of joint making is getting the lead to the heat of your solder and by roughly shaping the solder whilst in the semi-fluid state, or as some plumbers do by keeping the outside of the solder on the move round the joint until the joint is finished. This is the most expert method of joint making, and is done with the least quantity of solder.

Glazing Joints.

Some plumbers make the joint very roughly first and let it just set (with regard to soundness, it is not the wiping of a joint that gives it soundness, but it is owing to the metal being solid round the joint, which if so done need not be wiped off); after this they take a ladle full of semi-fluid metal and pour over the joint, and as quickly as possible wipe it off again. This kind of work looks exceedingly bright, and is not likely to be porous. A good joint should not have a mark of the cloth left on it, but should appear as though turned in a lathe, though it should be done the first time of pouring the metal on, if everything goes smoothly.

I may here take the opportunity of stating that joint making, like all other arts, requires a considerable amount of practice, and even after once being well learned, it is very easy for a good joint maker to get out of practice; but it should be remembered that this is no excuse for the duffing workman, for the plumber who has learnt to make a joint properly, and who may be out of practice, can always be told by the systematic style in which he goes to work, and will never find this to be an insuperable difficulty, but will naturally right himself after a small amount of practice.

Rolled Joints.

Sometimes it will happen that you will have to make a joint on a short length of pipe, say, for instance, that you wish to wipe a boss on to a piece 4ft. or 5ft. long, and you wish to make the joint by rolling it when wiping, here you

F 2

must fix the boss with spills or splints, or as shown at Fig. 118, to allow the work to turn altogether. Fix the joint as shown at Fig. 130; here the pipe is fixed upon three pieces of quartering. Take a ladle of solder and proceed as you did with the underhanded joint. As soon as the heat is properly got up take the cloth in the right hand as shown at Fig. 133, and turn or roll the lead round with the left (or get your labourer to turn it for you); at the same time hold the cloth in or between the fingers to as near the shape of the joint as you can; keep the fore-finger pressing on one side or end of the cloth and the second or third finger on the other side, so as to get the cloth as near the shape of the joint as possible.

Another way of making a rolled joint is by getting up the heat as before; take the cloth in the right hand, the pipe being closeish to you; place your cloth, which is now held by the thumb and forefinger only, on one end of the joint, and quickly roll the pipe away from you with the left hand, you pressing the cloth upon the pipe and about one-third up the joint; now quickly bring the pipe towards you, and with the second and third fingers press on the union, etc., and quickly roll the pipe again from you; then tone or smooth down the middle part by rolling the pipe as before. It may be necessary to repeat the operation once or twice at the ends, which of course you will acquire by practice. In finishing the joint the cloth may be held as shown at Fig. 133.

Fixing Joints on Axles.

Some plumbers are so deceptive over joint wiping that they will positively fix a piece of leaden pipe on a short length of mandrel and make the same to revolve upon axles in order to get the joint turned regularly and truly, but I need not say that such work does not after all require quarter the skill to execute as that of a properly fixed underhanded joint, nor should such work be practised, and, to say the least, I look upon such practices as nothing more nor less than deception; and many of the joints exhibited now in the Health Exhibition, South Kensington, for competition prizes, are made in this manner, and I am sorry to say that there is a large quantity of other work exhibited there executed in a similar style, which inexperienced judges look upon as specimens of extraordinary art workmanship, but which, if they knew anything of the work, they would pronounce execrable.

Pneumatic Tube Joint.

These tubes are required to be made very true at the joints, in order to allow the piston, or carrier, to pass on its

FIG. 134.

journey uninterrupted. In order to make sure of this the company adopt the butt-joint, which is made as shown at Fig. 134. A, B is the pipe; M, a steel mandrel, which is made to the same heat as the solder, and exactly fits the lead pipe, E. This joint is made as follows; First true the ends of your pipe that they butt together truly, and *shave* same in the ordinary way, then heat your mandrel to the heat of the metal, or hot enough to just brown a bit of cotton-waste; remember not to have it too hot, or you will not be able to keep any metal on the bottom part of your joint. Suppose your mandrel to be just the heat, place it in the pipe, and having threadled the rope through the next length, fix the ends of these pipes together with the mandrel M, half way into each end of the pipe, as shown at Fig. 134. See that the joint fits properly; if not just tap the open parts with your hammer; this will spread the lead laterally, and close the open parts. Proceed to wipe your joint as you did underhand joints; make it quickly, and as soon as you have finished pour some water on it, either out of a sponge or otherwise. This will set your solder round the bottom, which is the touchy part of this work, because of the mandrel keeping this hot. As soon as the joint is thoroughly set, have the mandrel drawn out.

Bad-shaped Joints.

Before I leave underhanded joints, I wish to show what may be well designated, "The Universal Plumbers' Joint." Fig. 135 is an elevation and Fig. 136 a cross section. It is

FIG. 135.

just the shape of a duffing made plumber's joint, and is too well known to require any description—in fact, how it is made is a puzzle.

FIG. 136.

Porous Joints, and Remedying the same.

Fig. 136 not only illustrates a bad-shaped joint, but also the crystallization of porous solder, and it is not at all uncommon to find good-shaped joints as porous as the one shown here; hence one reason why, after making a joint, you should, when hot, rub some touch round same, which will nearly always (for cold water only) stop up the pores and prevent sweating. Burnt solder will often be porous, but the real general cause of porous joints is through the solder's coarseness. A joint will often be porous if the metal is worked too cold. I have seen the touch (after the joint has been broken asunder) when it has penetrated its way through the solder, and the cells of the solder as it were full of the same, especially after the joint has been cut in two. Of course, it is no use to touch a joint over if it is for hot-water pipe work. Here you must always have your solder fine enough to prevent sweating, or over-cast them.

Sometimes the joint will be found to be porous through the manner in which the solder has been manipulated by

the plumber trying to get up the heat by using excessive quantities of metal. In fact, some plumbers think nothing of making it a practice to use the whole pot of metal, and take four times the time they should, before they attempt to wipe the joint, often causing the heat to run three times as far along the pipe as is necessary, which of course keeps the joint hot for a long time, thereby causing this metal to run to the lower part of the joint, whilst the top part becomes poor in tin, when porousness is the result.

Another way in which the metal is made porous is by twisting it continually, and in too large quantities, round the joint, thus working the tin to its outer edges; whilst at another time the plumber will shape the bottom part of his joint first, and then fold the metal up round the other part of the joint in a half-cracked, rotten condition, when he turns upon his solder, condemning it right and left. When you get a porous joint it can often be stopped by tapping the cellules of the solder together with a small hammer, and then burnishing the joint.

Branch Joints (Preparing).

These joints are made the same as the finished joints, Fig. 137. Proceed as follows: For small pipes take a half

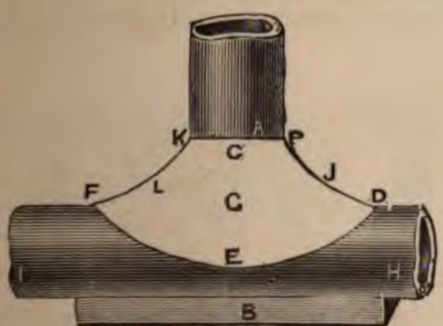


FIG. 137.

inch gimlet, and bore a hole (taking care not to let the gimlet enter the lead on the back part of the pipe or joint)

FIG. 138.

in the pipe at the point where the joint is required as at E, Fig. 138. For larger pipes, see "Soil Pipe Branches."

Bolt, Pin, or Tommy.

The bolt, or, as it is sometimes called, the "Tommy," Pin, &c., is shown in Fig. 139.

FIG. 139.

Insert the point A into the hole E, Fig. 138, and in such a manner that you can with the hammer knock the lead up so as to raise it, as shown at the sections B Q, Fig. 141, E G 140, and K 142 and 143. This is worked by striking the bolt at B or D in an upward direction. The object for

FIG. 140.

raising this part of the leaden pipe is to prevent the spigot, or male end of the pipe B K, Fig. 141, interrupting the passage or water-way through the pipe. Having the pipe

FIG. 141.

worked up to the right shape or size, prepare the male end by rasping it off as shown at Fig. 144. Next, soil and shave it as shown at E D, Fig. 144, but do not shave this male end too high, as the joint will not look well. The male end for ¾in. or 1in. pipe should not be shaved more than an inch from D to E. Fig. 140 shows the female part prepared and shaved; the side shaving line D E F is shown at Figs. 137 and D 142. Care should be taken to shave it truly, and to this shape, also low enough to get a good body of metal

at the side G, as you will be sure to get plenty at J Q, Fig. 141. Sometimes the end of the joint will have too much solder, as illustrated at E R. Fig. 141,

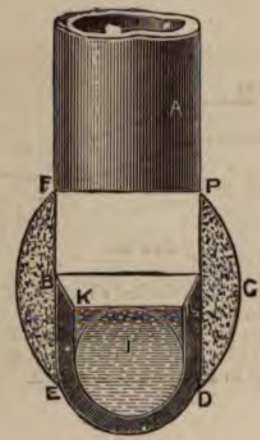


FIG. 142.

which thickness of metal will at a glance be seen to be quite useless. The shaving has much to do with this, for if shaved too short you cannot get your cloth in to wipe your solder rounded, nor can you at times keep up

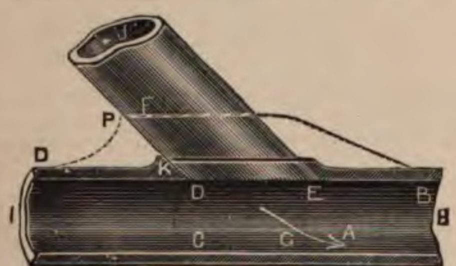


FIG. 143.

your heat, so that the solder will tend to break, thereby giving a leaky joint. The side of the joint, when finished,

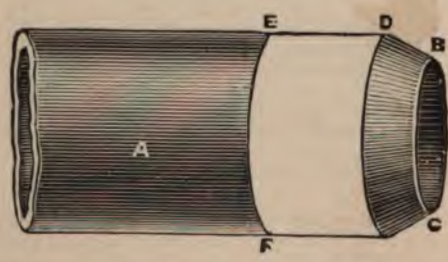


FIG. 144.

should appear rounded like that shown at G, Fig. 142, which in a great measure owes its shape to proper shaving, This diagram also represents the branch joint in end section.

showing the sides of the lead K E D turned up, so that the male end shall not be dropped below the water-way of the main-pipe, for, so sure as it is, it will always be a nuisance as regards noise, to say nothing of checking the flow.

By an examination of Fig. 141 it will show you the thickness of the solder at the solder line R E, a point where nine-tenths of the plumbers cause a thorough waste of the solder by bringing this line straight, instead of curving it as at the line P J D. Caution: When hammering up the sides of branch joints with the bolt, be careful not to injure the sides H G, Fig. 138, or bottom, with the bolt, or to leave a burr turned bottomwards into the pipe at K L, Fig. 141.

Slope Branch Joints for Wastes, &c.

According to theory all branch joints should be fixed so that there will be an easy sweep for the water, and, indeed, it should be, when possible, always put into practice; but circumstances will not always allow this. All wastes and branches of soil-pipes should enter in this manner.

Fig. 143 shows this kind of branch joint in section, which is prepared as follows:—Work the hole to the shape of the above figure, *i.e.*, much longer than you did for the square branch. The elongated hole for this kind of branch is illustrated at A B D E, Fig. 145. Then, take your male pipe and offer it into its place, and to as near the angle as you can; whilst in its place, scribe it to this shape (lines will be given for the setting out of this work when we come

FIG. 145.

to soil-pipe work and fixing), take it out, and rasp it off as at D E, Fig. 143, then soil and shave it. Take care that you shave the under part P D far enough back; otherwise, you will be pinched for room when wiping, and the joint will appear ill-made, and probably the solder will at this point be parted, especially if worked a little cold.

Soil-Pipe Branches.

In cutting the pipe for large branch-pipe work, such as 3in. or say 4in. soil pipe, the lead should be differently cut, whether for slope or square branches. It is best done as follows: First determine the length of the branch as from D to E, Fig. 138, D to E, Figs. 143 and 145, by placing the end of your prepared male part on E D, or by lines struck to the angle and size of the pipe. Having the length, take a small red-hot iron (but here put a piece of paper inside your pipe to catch the hot lead) and burn the two holes E D, Fig. 138, and the slot C F to about this shape, leaving a little at point E D just to turn up and appear like that at K Fig. 143, and also like that at D E K, Fig. 142. Next rasp off the sharp corners as shown at B C F I, Fig. 138, then with shavings, &c., just warm the lead about the hole to soften it, and with your bolt or dummy work up the sides to the shape of that shown at B E G, Fig. 140, or to that shown at B K, Fig. 141, or at K D E, Fig 143, or to any other shape which may be desired.

When learning to shave soil pipe branch joints, you should be very particular to keep the shaving on each side to one equal distance, as at E D, Fig. 142, also the ends as at F D, Fig. 140, unless it be for joints having great slopes as shown at Fig. 143, when K D will be required to be shaved longer than E B.

Some plumbers use the compasses to scribe the work true, but I should prefer you to practice without this tool, and by so doing you will be sure to succeed.

Elbow or Knuckle Joints.

These joints are a kind of elbow joints made by cutting the pipe on the splay, as shown at A B, Figs. 197 and 199, and working up the bottom side, something like that shown at H E B A, Fig. 198, to receive the end of your brass work, The joint is then soiled and shaved similar to a branch joint, and soldered up as shown at D in the drawing which illustrates the servants' closet (see Servants' Closets) having Sharp's basin fixed over an ϖ-trap, and branched into the upright lead soil pipe, Fig. 574.

Soldering Branch Joints.

If you require to solder small branch joints without irons, fix them as at Fig. 137, in which you will see a block, B, placed under the joint (which must not be too high), the object being to block up the joint so that you can wipe clean round the bottom of the same. Neither must it be too low, but just sufficient to keep up the heat. A good height for

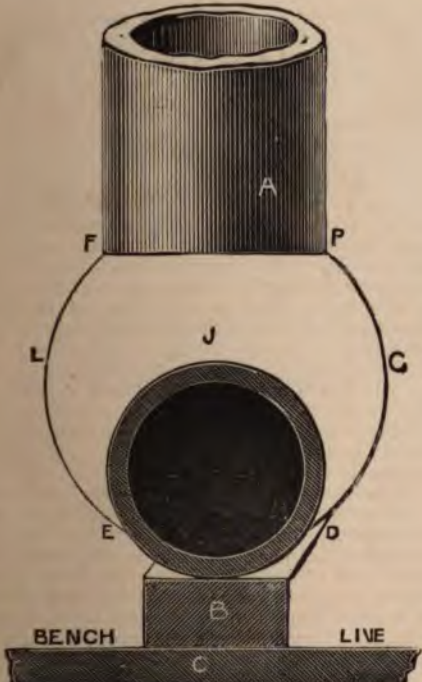


FIG. 146.

½in., ¾in. and 1in. joints is a piece of wood ¾in. by ¾in., and from 4in. to 6in. long, or, in other words, the bottom of the solder-line, E, Fig. 137, should be kept up from the floor, &c., ¾ of an inch [see end view of Figs. 146 and 147, one a soil-pipe, the other a 1in. pipe]; this will answer for almost any joint. After this, proceed thus: If making the joint on the floor, straddle the pipe on the

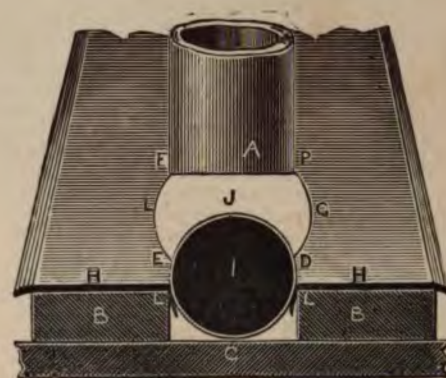


FIG. 147.

F end of the joint, take the solder (two of lead and one of tin), and with your splash-stick splash all round the top part of your joint [Fig. 137] at A P, also round F D; keep at this as fast as it will hang together until you have shaped the joint, or as well as you can with the splash-stick; the heat may be kept up as before directed by splashing an inch or more beyond the soiling. Now, when you can feel the lot to be in a semi-fluid state, take the branch cloth (which your mate has made hot over the solder) in your left hand and wipe all round the *top* part and left-hand side of the joint from P to K, then round the bottom and centre part as at G; bring this round to the line F K; next take the cloth in your right hand, and as "quick as thought" wipe the top part of the right-hand side, or round P C K; then J G L, also the bottom, and then as a finish wipe down from K L, and off at F. If you work quickly, you may do it without showing the marks of your cloth when coming off.

Should your solder be rather coarse, it would be best to use yourself to first wipe clean round the top part of your joint from P C K to J G L, and finish as you go down the joint.

Fig. 142. This diagram shows the joint finished, but cut in half at the solder B G, as also the bottom part of the pipe. This is as the solder should be when finished, *i.e.*, even in thickness, and strongest across the joint at B.

Fig. 146, shows the end view elevation of the joint and the solder on the sides; that is, true and round where the strength is required. It also shows the blocking up of same ready for wiping.

Fig. 147 illustrates a soil pipe branch joint packed ready for wiping over again. This method of packing is somewhat different to that shown at Fig. 146, inasmuch as in the Fig. 147, B B illustrates two bricks with paper, H H, which is for the purpose of catching or packing, up the solder, keeping it within half an inch or so of the joint. The paper should be tucked close to the lead to prevent the solder running away.

Let us again examine Fig. 143. This is a joint made on the slope. When wiping it splash on the solder as you did Fig. 137; but when wiping, first shape the back part from P to D, Fig. 143. When the pipes lie at such an angle that you cannot get the fingers and cloth between them, wrap a piece of fustian or old cloth round a small round stick

(known as a cloth stick, cat's paw, solder mop, &c.), a suitable size for going between the pipes and wiping this part; then finish the two sides and come off from F to B, keeping this rounded as shown by the dotted lines. Of course, the sides of this joint should appear like those in Figs. 142, 146, and 147.

Wiping Branch Joints—Horizontal into Upright.

Fig. 148. This joint can be made by an expert workman in its place, but three-fourths of the plumbers cut the upright pipe in order to bend it, so that they may make it on its back. It, however, should be made as follows:—Having prepared the joints as other branch joints, fix the collar, or board blocks, as shown at H K, about 1½ in. below the shaving line, then splash your solder well up the soiling and prepared part of the joint, get your solder to the usual working point, and then with a warm cloth wipe

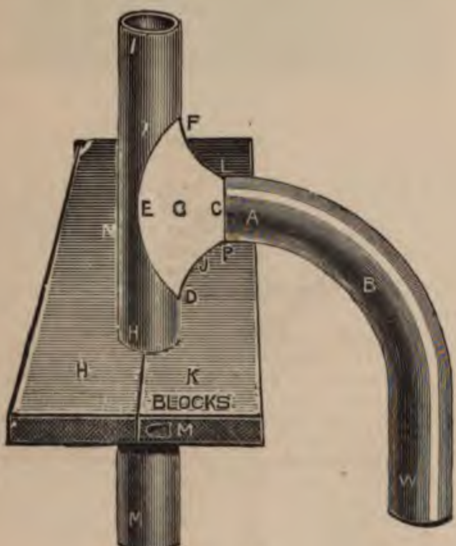


FIG. 148.

from about midway on the other side of the joint, and up over the top L F to about E G C, taking care to keep it round; place your hand under the branch and work the joint from where you began, round the bottom and up to C G E, and off at E. The art of wiping this, as all other joints, is *quickness* without weakness of the nerves. Try one or two by way of practice, and you are sure to win. Where the pipe will permit, the same may be bent back out of the perpendicular line, and thus the branch joint can be made *at first* much easier than when quite upright.

I give this hint to those who have declared it to be impossible to branch a horizontal pipe into a perpendicular one. Many good plumbers wipe their joints without shifting their cloth from one hand to the other, but I at times prefer to use both hands, also two or more ways of doing different work, of which the above is an example with its advantages.

Taft and Block-Joints—The Taft.

The taft is after the style of the copper bit-joint, so far as regards its shape, but is made with coarse instead of fine solder. These joints may be made by the unskilled workman; in fact, some plumbers call them the "duffers joints," and, in a measure they may be right; but, nevertheless, that does not alter the quality of the joint, and I must tell these facetious ones who choose to dub them by that ignominious title, that, when properly made, they are as strong as the plumbers' joints, often made by those who run them down. I have used them in well work when wiping the lengths on the stages, and have always found them to answer every purpose. Let us examine this joint.

Fig. 149 shows in section the general shape this joint is

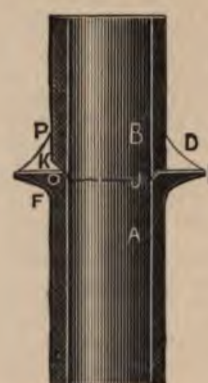


FIG. 150.

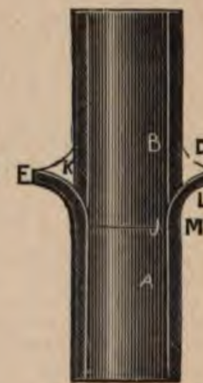


FIG. 149.

made. The flanged part E, is first opened with the turn pin to the desired width, then the outer edge is worked back with the mallet or otherwise, to the shape shown at E E, and often as at K E, Fig. 150, which is very thin at its edge, but which may be thickened by beating the edge of the lead from E towards J.

When opening the pipe, as at Fig. 149, do it steadily and slowly, using plenty of water on the turn-pin; be sure to only drive the turn-pin very gradually; by adopting this precaution, you may with your mallet, &c., as before spoken of, thicken your pipe just as you please, but it is not always necessary, as the solder runs down and unites the ends or sides of the pipes at these intersecting points, thereby causing them to become one solid mass of metal. Here, of course, the pipe must be cleaned well down into the joint, but should there be the slightest objection to this point, then go to work and make the joint as at Fig. 150.

Here the flange may be knocked over to as thick again as the pipe, and the spigot end, or B, not allowed to enter quite so far as that at Fig. 149. The preparing of this we will for the present let stand over; but, at any rate, *let it fit well* next to the soldering.

Here is a very great advantage gained; for, in the first place, not more than a quarter of the solder is required about the actual joint to obtain the same strength, which I, as an engineer and plumber, together with some of the very best authorities of the day, on the strength of lead pipes, &c., say that it is as strong as any other part of the pipe; in fact, when testing this joint, not one burst within 1¼ins. of the joint. The pipes used for these experiments were:—

½in. from No. 14 to 30.
¾in. ,, No. 22 to 42.
1in. ,, No. 30 to 60.
1¼in. ,, No. 42 to 52.
1½in. ,, No. 48 to 84.
2in. ,, No. 96.
4in. 7lb. to 12lb. to the foot made.

There were from 40 to 50 joints made by myself, simply as a test of economy.

There is also another advantage attached to using the taft-joint, viz.: you can employ almost anything in the way of solder, or, if you like, can, with pot and melted lead, burn the joint with lead as follows: Place a small wad of blotting-paper at about A (or a piece of rag tied to the end of a piece of string, threaded through the pipes), and fill up the pipe with sand; then prepare the end of B, place it in as shown, and send some more sand down this pipe to about B or say 3in. up above the joint; you can get it solid by letting through a few shots just to ram the sand down. Next fix a collar round the pipe A, and bank it up with sand to about B; then, by first wrapping a little piece of sheet-lead round the edge of the flange to the desired height of the joint, you can with sand bank up the outer part of the sheet-lead and run your joint as follows: Take a ladleful of nearly red-hot lead and keep pouring it round the joint until the pipe and lead are thoroughly amalgamated; have a small stick to push into the hot lead, to try if it is quite solid. Your joint is now burned together. Caution.—Take care that your pipes are thoroughly fixed independent of each other, or they will part in the burning. Force the sand out with a force-pump, or as best you can. I did not intend to describe lead-burnt joints here, but have done so to show that any kind of solder, or even lead, can be used to these joints.

Flange Taft Joints.

Fig. 151. These joints, in shape, are exactly the same as the taft-joint, the difference being that the joint is made on a kind of base, with a flange of lead below, as at C E, and with the floor boards, or in cisterns, roof

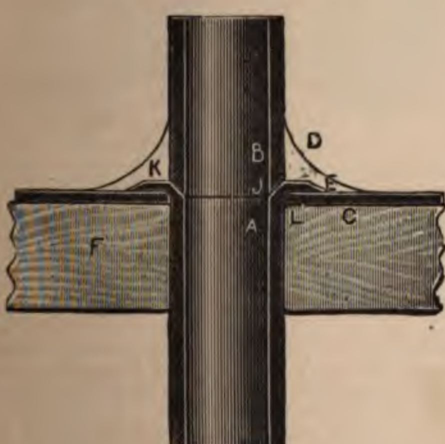


Fig. 151.

work, the stages in deep wells [see Wood Stage and Clip Block in my Pump Work, also fixing Jack Pumps], &c., as shown at F, Fig. 151. there is also used by some plumbers a flanged piece of lead, as shown at C; this is for the purpose of extending the size of the joint, and to save turning the end of the pipe so far back; it also prevents the solder running through the boards, should they be cracked or otherwise bad. These flanges are or should be always fixed over the stages in wells (also see block joints, Figs. 149 and 150).

Stage or Block Joints.

Fig. 152 is a kind of taft joint which very much resembles flange joints, excepting that the flange G is first worked or knocked into the hollowed block, as at L G H, and shaved; then the end of the pipe is shaved from E to L, and pushed up through the prepared flange. Take the turn-pin, and open this end, being careful not to drive the lead too hard against the flange to cut the lead with the woodwork. Shave the inside. Now prepare the pipe B, and be sure that your shaving is long enough, as those not acquainted with this joint are apt to be deceived about its proper length. All being ready, proceed to solder your joint in the following manner:—

Take a ladleful of good hot solder, and splash it on as quickly as you possibly can, to get up the heat; wipe the joint by taking one good sweep round with the left hand, take the cloth in your right hand, and begin where you began with the left, and with another good sweep, come round to where you last left off; then from the top of the solder bring the point part of the cloth to the same line as the other part of the joint and off. Or, if you can, get your joint with one hand, wipe all round at once without lifting your cloth, and finish as above. Part your surplus solder, and pick it up ready for another joint.

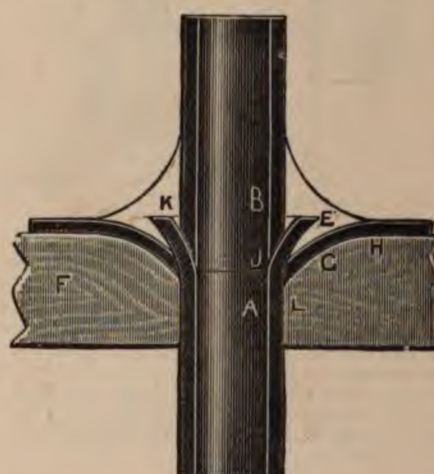


Fig. 152.

I may here mention that when making these joints you should *make sure* that they are properly tinned, which of course is done by getting the joint into a thoroughly fluid condition before attempting to wipe it. See that no dust or dirt has fallen into the joint before the solder is applied.

Plumber's Joint Making with Lamp.

The following is a method of making joints without a pot, ladle, or irons. It is illustrated at Fig. 153.

You see that P P, is the fixed pipe, which may be either upright or horizontal; J the joint, shaped, F the flame of a lamp known as Cotton and Johnson's spirit-lamp. This lamp is made as follows: B is a small boiler half filled with methylated spirit, under which is a small lamp, which may be regulated by turning the wheel A, Fig. 153.

Off the top part of the boiler a tube is taken down the back of the lamp, and its point bent to form a blow-pipe. The lamp being lit under the boiler soon causes the spirit

to boil, thus generating a very inflammable gas, which, on being checked at the end of tube, rushes out rapidly, and on being held against the joint or a piece of solder will melt it. The way to make this joint is as follows: Take

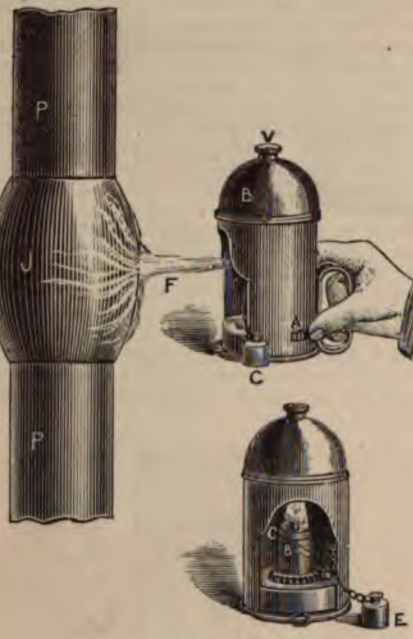


FIG. 153.

some plumber's solder, run into a long strip, say 12 to 15in. long, ⅜in. thick, 1in. wide. Hold the lamp against the joint and get it hot enough to melt the solder, which, of course is done by putting the solder on in small portions. Keep at this constantly until you have sufficient on. You can almost shape the joint with this strip of solder. Having all the solder on you require, keep your heat up by twisting or turning your lamp round the joint, then take a suitable cloth and make your joint in the usual way.

Patches or Repairing Leaden Pipes.

Frost Bursts, and Cause Explained.

Fig. 154 illustrates the pipe split open by the frost. Every plumber should know that water expands from 39·2° F until it reaches boiling point; therefore, water is at its greatest density at 39·2° F, and it expands in falling to 32° F, the actual amount of expansion being about ·0001269 of its volume at 39·2°. The water will then remain at 32°, and will gradually solidify, until the whole of the latent heat (143 units) is extracted, when we have ice at 32° F the water having expanded 9 per cent. during solidification. Below this temperature the ice contracts in volume, its coefficient of contraction being about ·000067 for every 1° F. through which the temperature is lowered. Now, this being the fact, suppose the pipe above, which is drawn from full size, to be of lead, the whole at, say 30° F, the outside of the ice has swelled the pipe, and at this point the outside of the ice breaks and allows the watery part to again get to the lead. This again swells as before, and so on, until there is a large burst, sufficiently large to allow for the expansion as at A B E F, Fig. 154. The softer part of the ice, if I may here use this term, which strictly speaking is inaccurate, will flow towards this opening, and this accounts for the prodigious size of the burst, A B E F. It is not at all uncommon to see a ¾in. lead pipe with an opening 4in. or 5in. long, and sufficiently large to take in a good sized marble. A brass globe, 1in. in diameter, was filled with water, which was afterwards frozen, when it burst. The pressure required for this purpose was estimated at not less than 27,270lb. to

FIG. 155. FIG. 154.

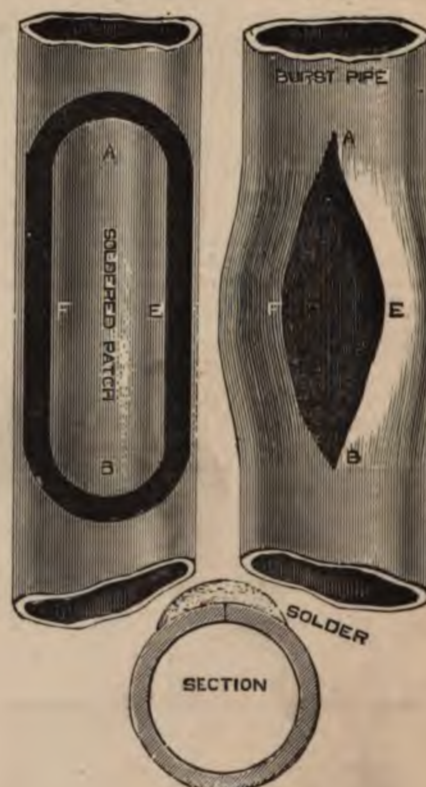


FIG. 156.

the square inch. This will give you an idea that no pipes will withstand the action of frost. To repair a burst in a leaden pipe, first see that all the water is out of the pipe and quite dry. Take a small hammer, &c., and close in the sides E F, Fig. 154, and in such a manner that the pipe will appear right. Next soil it all round, and say 4in. above and below the slit, but for large pipes you may soil it as shown, instead of all round; now shave it, "touch it," and with a splash-stick splash on sufficient metal to get up a good heat. Afterwards wipe the patch as shown at SOLDERED PATCH, Fig. 155. By patching the pipe thus you save putting in a new length of pipe and one joint. The work, if the pipe is good, will be as sound as wiping in a new piece, though, perhaps, it does not appear so agreeable to the eye of most plumbers. At any rate, it is not a quarter the expense of cutting and putting in a new piece. Fig. 156 is a section of Fig. 155 at E F, showing that the pipe is equally as strong as the lead pipe, if properly repaired.

Soldering-up Bursted Copper or Iron Pipes.

It will sometimes happen that you will be called upon to temporarily repair an iron or copper pipe, and it may not be convenient at the time to cut it out; you may be able to do this by the use of solder, which is done as follows:—See that the pipe is dry, then file the slit and solder it with the copper-bit and plenty of fine solder, as you would were you copper-bitting up a leaden pipe.

Repairing Pipes with Putty Joints.

Sometimes it will so happen that you will be called upon to temporarily repair a pipe which is impossible for you to solder; then, under those conditions, you must go differently to work. The following is the plan I always adopt, and which, I find, if properly done according to the instructions herein given, will withstand any pressure given by our water companies. First get the pipe *thoroughly* dried, and with some quick drying gold size, paint the part to be repaired; then get some white lead and stiffen it with some powdered red lead, so as to make it hardish putty, place a thin layer of this, say ⅛in. to ¼in. in thickness, over the bursted part of the pipe, and with some good strong calico, painted with the gold size, neatly wrap the

FIG. 157.

red lead to the pipe, using three or four thicknesses of the painted calico; then with some twine begin at one end, as at A E, Fig. 157, and carefully, but *strongly*, bind up the joint, laying the twine in rotation as shown, and finish as at J B. Should it be for exceedingly high pressure, make the putty from dry red lead and gold size.

Common Putty Joints.

Our work on pipe joint-making will not be complete unless we speak of making ordinary putty joints. I have particularly noticed that many plumbers are in the habit of making these joints without sufficient care. They think that because it is only a putty joint, anything is good enough. I contend that this joint requires quite as much care as other parts of the trade; for what is worse than a leaky joint to the arm of a closet-basin, and is there any leaky joint so numerous as the putty joint.

To make a good putty joint, let the pipe enter the arm of the basin about 1in. or so. After this, see that it is perfectly dry and free from water; then take some kind of paint, and paint it well inside and out, after which take some stiff red and white-lead putty (*many plumbers use ordinary putty, but it will not last the time or stand quarter the pressure*), and with this make your joint to the shape of Fig. 157. Next take a piece of calico or canvas, about 3ft. long and about 2½in. to 3in. wide, and rub the paint tool over same; then wrap up the joint from A to B by winding your wrapper carefully round and round, true and tight; take about three yards of middling thick twine, and make same good to A E, and then wind it tightly round your wrapper, as shown, until you come to B F, after which make it fast as best you can—a good plan is to tuck the end under, as shown at J. After this, rub the paint tool over same, to protect the twine from dampness. Care should be taken not to disturb this joint after it is made.

Red and White Lead Joints Generally.

The red-lead joint, above all others which the plumber has to make, receives the least attention. I will begin by explaining the first thing to be done before you commence to make the joint. First see that the parts are *thoroughly dry* and free from water or dampness. Secondly, see that the parts are not dirty with rust, &c. Next, well paint the parts with good stiff paint before putting the putty on to form the joint.

Red Lead Putty Making.

The red lead (if all red lead be used) should be mixed with boiled oil (or if required to set very quick, with quick drying gold size), make the putty stiffer than the ordinary glazing putty, and well beat it with the hornbeam dresser or hammer.

White and Red Lead Putty-making

If white and red putty will answer your purpose, it is best made by mixing as much red lead powder with the white lead as will stiffen it to suit your work; for boiler man-holes it is required to be made as stiff as possible, but for iron guttering not quite so stiff. When you have put your putty on the joint, whether it be for manholes, guttering, or anything else requiring the use of putty as a water-joint, see that the same is thoroughly squeezed or pressed out from the work, viz., only just leave sufficient between the parts forming the joint to make it water-tight. The same rules apply to closet-setting, &c.

Patching on Roofs, &c.

You will often be required to repair a leaden gutter, &c., on roofs or otherwise, and which is generally a job given to the apprentices.

In some cases all that will be necessary for you to do is to simply shave the part about 1in. on each side and ends of the crack, touch it, and stick a few clout nails down the centre to prevent the lead rising when soldering, then solder the same in a manner similar to that shown at SOLDERED PATCH, Fig. 155. At other times you will not get over the work quite so easy, for it may happen that under the crack is soakingwet, which must be dried before you can attempt to solder it. Suppose it to be only just a little damp, then you may be able to place some brown paper between the lead and woodwork, which will keep the damp away during the time you are soldering.

Level Patching on Roofs, &c.

Sometimes it will happen that you must make your patch in such a manner that it will be quite level with the surface of the lead when it is finished. For instance, suppose the crack to be across the centre of a trough gutter which has but little fall and shallow drip, say 1in. drip, and that you wipe a raised patch of ½in. across the gutter, here you practically reduce the useful effect of the drip to about half,

which in stormy weather would be the cause of the water getting through the drip. Again, it may be that the patch is to be made on a flat, where people have to walk about, or on the top of a bay window having casement sashes opening on to its top. In these places the patch must be flat and quite level, which is done as follows: Pull up your lead at the crack and sink the boards down to, say, ½in, as shown at W A 4, Fig. 158; then place a piece of lead

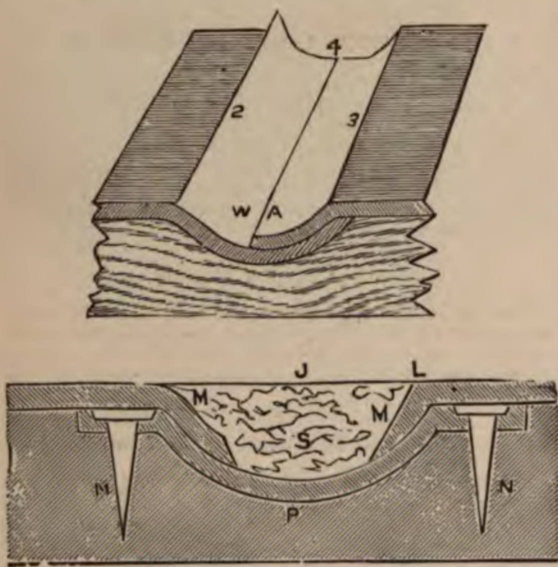


FIG. 158.

underneath the top lead, shave it, and nail it; afterwards wipe it quite level, which may be done with the solder cloth or by the use of a solder stick as shown at Fig. 159.

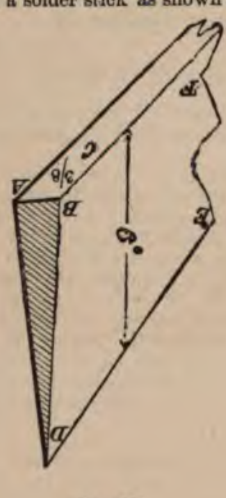


FIG. 159.

Solder Stick for Angles, etc.

The side E D is the edge, which should be ¼in. in thickness, but a little rounded. The size of this stick is about 2½in. from D to A, and about 4in. from D to E. You will at once see that, should you be soldering in an angle of, say, a trough gutter, that it is easy to (with this stick) clear the solder away quite level, and without the least trouble; you can also perceive that with this stick you can strike the metal from 2 to 3, Fig. 158, perfectly flush.

Killed Spirits.

[*Also see Tinning the Bits.*]

Take some spirits of salts (otherwise known as hydrochloric acid, muriatic acid, hydrogen chloride, HCl), in a gallipot, and put as much sheet-zinc in it as the spirit will dissolve: you have then obtained chloride of zinc (ZnCl), or KILLED SPIRITS.

(Caution, when making Killed Spirits.)

A little care is required when making this, as the acid is decomposed and is spread about by the discharged hydrogen, and will rust anything made of iron or steel, such as tools, &c. Sal ammoniac dissolved in water will answer the purpose of the chloride of zinc, especially for cast iron.

Having the killed spirits, as it is sometimes called, ready, file the end of your iron or bit, and plunge this part into the spirits, then touch your dipped end with some fine solder, and dip it again and again into the spirits until you have a good tinned face upon your iron, &c.; next you require a spirit-brush.

Spirit-Brush.

You can make this by cutting a few bristles out of a broom or brush, push them into a short piece of compo tube, say, ¼in., and hammer up the end to hold the bristles; next cut the ends of the bristle to about ⅜in. long, and the brush is ready for use.

Soldering Iron to Lead.

Suppose you want to make a joint round a lead and iron pipe. First file the end of your iron pipe as far up as you would shave it if it were lead, and be sure to file it quite bright and free from grease, as before mentioned; heat your soldering-iron; then, with your spirit-brush, paint the prepared end of your iron with the above killed spirits of salts, and with your bit rub over the pipe plenty of fine solder, until the pipe is properly tinned, not forgetting to use plenty of spirits; if you have no killed spirits you can tin brass or iron with *composite* candle instead of spirits; this done you can put your joint together, and wipe in the usual manner. Caution.—Do not put too much heat on your iron pipe, either when tinning or making the joint, or the solder will not take or stand. Should you be without the copper bit, and want to tin the iron pipe, you may do so by first painting the end with the killed spirits of salts, and then, by dipping it into the solder pot; but be careful that the metal is not too hot, nor to have too much spirits on the pipe at one time, which would cause the metal to splutter about. Brass-work may also be tinned in this manner, but do not make a practice of this, because, by dipping the brass, which is composed of two parts copper and one part zinc, the zinc is, especially if the metal is very hot, apt to get into the solder, and will cause it to work short, as though the metal were burnt. [See Solder Cleaning].

ELBOWS AND BENDS.

Elbows or Throated Bends.

To give you an idea what the bend is like, see the finished one at A D F B, Fig. 170. The illustrations will explain the marking out, as I have given one to suit every kind of elbow, and the different methods of taking the angles for the same.

Sometimes it will suit the place and plumber best to make elbows for rain water, soil pipes, &c.

First proceed to take your bevel, which is done with an ordinary large wooden bevel, and as at 2 U, Fig. 166, take same, and on the floor strike two parallel lines to represent the pipe as at A B I G, Fig. 169. Then two more parallel lines to represent the angle as at E F, and C D, Fig. 169. Fig. 160 shows the manner of cutting the pipe, which if cut properly requires care. Fig. 161 shows a plumber's mitre block for cutting these elbows. A A, B B are the bevels, which require great care in setting out; the method of cutting out will be understood after inspecting the following figures, more especially Figs. 166, 168, and 169. First, let us suppose the soil pipe to be seamed up or drawn pipe,

FIG. 160.

if so, place the seam on one side, as it will be more out of the way when soldering, &c.

The bottom of the bevel cut *must not go within one inch* of the bottom of the box. The one side A C should be cut ½in. past the other, as at D, so as to form the lap when cutting the pipe. At the letter E, Fig. 161, is another cut, called a square cut; this is for the purpose of making sure when cutting soil pipe that it shall be cut off square. Of course this cut is put at right angles with the box, and truly upright. F G H are pieces of board nailed on to steady the sides. This box is very handy when properly made, as if cut to the usual angle it will suit any ordinary outgo elbow, as the angle to the trap can be adjusted when wiping on the trap.

The mode of cutting elbows is very simple after it has

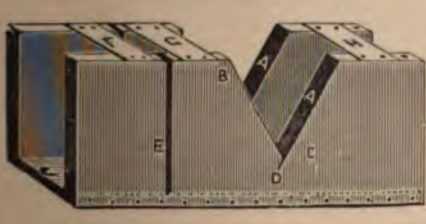


FIG. 161.

been worked out. If you want a 4 in. square elbow, as at Fig. 164, mark the pipe all round as at C D, Fig. 162.

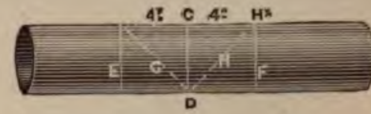


FIG. 162.

This is just where the centre of the throat C and the back of the elbow D are to come. Then mark off each way as at E, F, the distance lines or the diameter from C D of the pipe (*Notice*, this is for a square elbow), and draw the dotted lines G, H, taking care to leave about ½in. for a lap, as shown at the end of the dotted line H, and also at A, Fig. 163.

Take the saw (a panel saw is best for soil pipes and general shop work; the teeth are just the size for lead cutting), and cut the piece out as at Figs. 160 and 163. Again, be careful to cut A a little deeper or longer than B, as shown at I Fig. 160. Now take the dummy and work up the female cut A, as at Fig. 163, for the male cut B to

FIG. 163

enter. Also see section at A B, Fig. 165, which illustrates the way the lap should run when the pipe is fixed. Then soil to the lines (about 5in. each way) J K, Fig. 163, and shave it to the lines L, M, so as to make the joint look about 1½in. wide, when the elbow is pulled up; next pull the elbow up as at Fig. 164 (but do not pull it up before you

FIG. 164.

are sure that it will fit, because if you bend the back lead two or three times, you will be apt to break this back lead, so that once pulling up should suffice). Close the sides and knock the corners round, as also shown at O; then with a piece of string, tie as at N, and it is ready for soldering. Instead of string, you may use a strap of lead nailed on a stick to stiffen it, or you can burn the lead so as to keep it steady whilst soldering, which is done as follows: Place the lead pipe upon two pieces of quartering, &c., or on your soil pipe blocks; let its other end stand up as at Fig. 164;

now splash the metal all round your joint until you have got up a good heat; and with a suitable cloth (one about 3in. by 2½in. square), wipe from O towards the throat, then let the mate turn the pipe and wipe the other side: the joint should appear as that shown at B, Fig. 170. After this with your dummy, knock the throat lead down flat as at B 165, and the elbow is finished. Some plumbers wipe

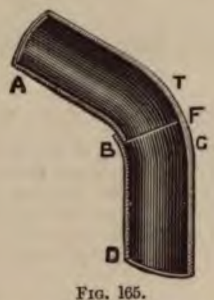


Fig. 165.

only one side of the joint at a time, but this is considered very slow work. When this is done you may wipe it one side, swab it and turn it, then wipe the other.

N.B.—If you wish to leave *much* back or uncut lead, as at O, Fig. 164, you must cut your lines G H, Fig. 162, accordingly (a little shorter). Of course the corners are gently rounded after you have shaved, and the elbow pulled up

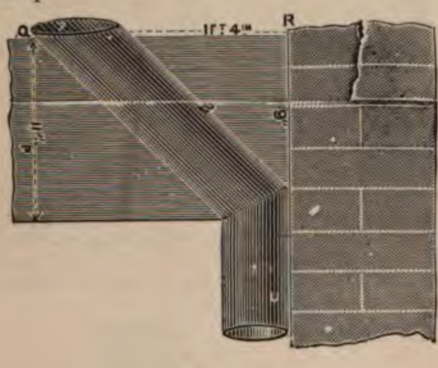


Fig. 166

If you want to make an easy elbow, as shown at Fig. 166, you must cut accordingly as follows. *This method also suits every kind of elbow.* Take your dimensions at Fig. 166, which represents a 4in. socket pipe. P 11in. joist; from Q to R is 1ft. 4in., called the floor line. This is all that is wanted in this case, but for closets we take the

Fig. 167.

length of floor-line from wall to the *centre* of the pipe J. Now set the work out (generally on the floor) full size, first draw the floor line R Q, then the ceiling line, then the wall line R U, then the pipe lines 2 Q U, &c. Next refer to Figs. 168 and 169. Here the line E F, Fig. 169, represents the line 2, Fig. 166, and D C, Fig. 169, represents the line Q, Fig. 166, and so on. Now you require to know where to cut the throat of the pipe, in order that the elbow may afterwards come up to the desired angle at the first pull; for the distance of the cut refer to I F and F G, Fig. 169. This is obtained by simply putting a square across the pipe lines as at G D, so that the line G D may come to

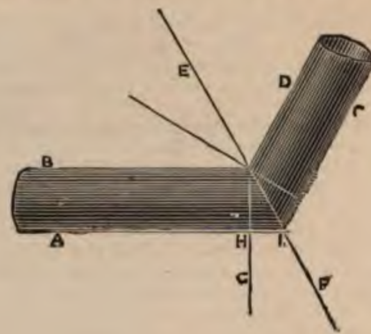


Fig. 168.

the meeting point at the throat of the elbow, as shown at D. Now measure the distance from the square line G to F, or from H to I, Fig. 168, and that distance marked round the pipe, as at E F, Fig. 162, will be the cutting point across the intended throated part, as shown at A B C, Fig. 167, when the elbow may be soiled, shaved, and soldered as before directed.

These elbows are frequently made to save the expense of proper bends. They are exceedingly useful for rainwater-work, though often used for closet-work. When used for

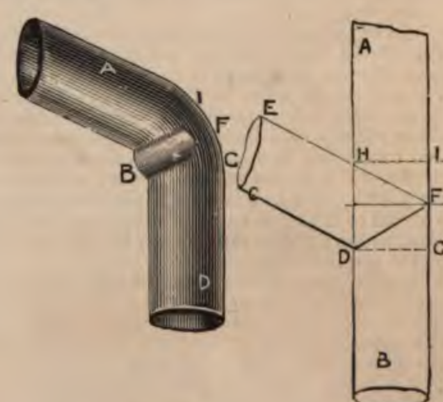


Fig. 170. Fig. 169.

the latter purpose, the pipe should have as much fall as possible, though actually elbows should not be used in closet-work, unless it is from a nearly horizontal to a vertical soil-pipe, such as would occur from the outlet of a trap to the branch joint, or to the down pipe or vertical soil-pipe. In this instance you will perceive that the elbow will work equally well as the bend, because the fall is good, and the soil tumbles over the throat of the elbow direct into a vertical pipe, exactly as though it were simply a branch into a soil pipe. Why not, is a question for those who con-

demn them. Some plumbers work the throated part of the bend to a rounded shape, in order that nothing may lodge on the sharp part of the throat when passing from a higher level, when a scanty supply of water is laid on to the closet apparatus, but this accumulation of soil and paper is not at all likely to take place in well-arranged work, any more than it would were it a branch joint. Brass caps and screws are sometimes soldered on, say at F, Fig. 170, in order to clean out the pipes, but such work is usually laughed at.

Bends.

There are many methods of making lead bends, some with dummies, others with bolts, bobbins, &c., others for pressing the lead into the shape of the bend required, others cut the bends on the back, whilst others cut them on the throat, and many make them by cutting them on each side, as at Figs. 171 and 172. It will be necessary for me to explain at length some of the best methods, whilst those not much practised will only get a few words by way of notice.

Bend Making.

If you take a piece of ordinary light 1½in. lead pipe and pull or bend it sharp round, it will cripple or crinkle at the "throat" [see B E X, Fig. 183]; the larger and thinner the pipe the more it will cripple, therefore in large pipes we must go differently to work. Fig. 171 shows a length of drawn pipe with the solder undone at B, next on the other

FIG. 171.

side cut the pipe down the centre to suit the length of your bend, as shown at A B, Fig. 172. I will here explain the theory of bend making, in order that you will have a better

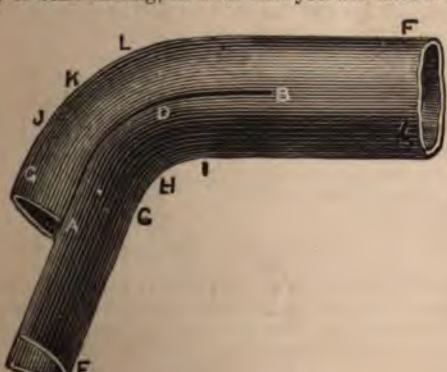


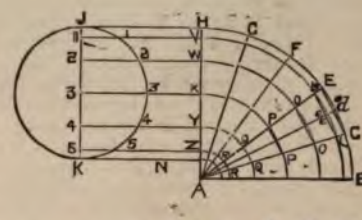
FIG. 172.

chance to follow and understand what is written upon this very important branch of the plumbing trade.

The Theory of Bending.

Figs. 173 and 174 will assist in the description. Let J K be the size of your pipe to be bent. Draw the line J K; divide half the circumference of this pipe into, say five parts, as shown at 1, 2, 3, 4, 5 on the circle. Next draw the lines J H and K N square to the line J K; now strike the

FIG. 173.



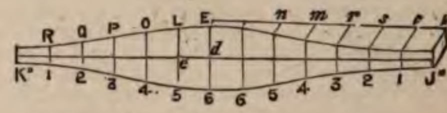


FIG. 174.

line H A also square to J H, and anywhere on this line as at A, strike the throat line, also the back as at H G, &c. Draw the parallel lines V 1, W 2, X 3, &c., through the points on the divided part of the circle, and strike the curved lines V L, W O, X P, Y Q, and Z R; next divide this curve from H to B into five, or as many parts as you choose, as shown at H G F E C B, and also divide one of these as at A *d*, and draw straight lines from point to point as at L L, O O, P P, Q Q, R R; next strike the line J″ K″, Fig. 174, and measure off from J 1 in Fig. 173, and set this distance on J 1 Fig. 174; next measure from 1, 2, Fig. 173, and set this off on Fig. 174, and so on until the whole is marked off. When all is marked off and laid down as from J to 6, Fig. 174, continue from 6 to K, which will be the exact distance round the bend. From *d* to E, Fig. 173, measure off the distance of the short line, and place this on the line K J, Fig. 174, as at E *d* and *d* 6; also measure off L *e*, Fig. 173, and place this on the line L *e*, Fig. 174, and so on until you have the lot. Now draw the curved line through the distance or points R 1, Q 2, P 3, O 4, L 5, E 6, and this will be a development of one section H G, Fig. 173.

Now, seeing this, it is quite clear that when the pipe was in a straight line, the back and throat were of equal length and substance, therefore the piece, Fig. 174, across R 1, was the same as that across E 6; this being the fact when pulling up bends, as at Figs. 180 and 182, the molecules of lead must be either driven, as it were, into a heap at R 1, Fig. 174 (but less so at Q 2, P 3, &c.), or worked from K towards E, that is if you are not to strain the back. For striking out bends also see Fig. 198.

Split Bends *(continued)*.

Now return to our split bends. It will be quite as well if you first set out this bend on the bench, then you may measure round the back, as from G J K L, Fig. 172, to obtain the distance of the cut, which should always be 3in. or 4in. longer than the bend. You may also in this way obtain the correct length for the throat G H 1, here you will see that you have a quantity of lead to spare, *i.e.*, from A to E, all of which has to be got rid of in uncut bends. Also see the distance that it is round the bend at H G F to B, Fig. 173, against that round the throat [also see Fig. 190], and as per dots with the compasses measure from G F D B,

all round the outside; after this, measure from the inside or throat part from I to C and H, and compare the difference. Some plumbers shift the particles of the lead from the throat part to straighten the back, but how many? not one in twenty. After you have cut the pipe, open the throat part, bend out the sides, and pull this part round, a little at a time, then with a dummy, Fig. 181, work the internal part of the throat outwards as shown at A, Fig. 182, to as nearly the shape as you can. Go carefully to work, and do not attempt to work up the sides A D B, Fig. 172, until your throat is nearly to the proper shape, as at C D, Fig. 171, after which you may do so with a small boxwood dresser or bossing stick. It is not necessary to explain minutely what a bossing or dressing stick is, as they can be bought at almost any lead merchant's, and are illustrated and explained in my roof work. The dresser is shown at E, Fig. 12; the bossing stick is somewhat similar, the only difference being that it has a rounded face instead of flat. Keep the dummy up against the sides when trueing it. If you have proceeded properly with this throat part, you will not require to work up the sides or edges, as in working the throat back, the sides will come up by themselves. Next take the back, pull it round a little at a time, the dummy being held inside, with your dresser work the two edges and sides slowly round, and the back will follow. Never strike the back from the underside with the dummy. After you have made a dozen or two you will be able to make them as fast as you please, but do not hurry them at first, as the greater part of this work is only to be learned by patient application, perseverance, and practice. Some plumbers when making bends use the small "bossing mallet," Fig. 175, and "dresser." If the edges

FIG. 175.

should not be even (*which they ought to be*), you must rasp them off with the plumber's rasp, Figs. 176 and 177, which show the flat and round sides. This rasp must not be too coarse, or it will drag the lead; nor too fine, or it will clog

FIGS. 176 & 177.

up. It should be a medium cut, and it is all important to a good workman that his rasp is always kept in good condition, viz., with the teeth nice and sharp, as the work is then done with facility and despatch. In working these bends I need not say that you must keep the back the same thickness as the sides, which is done by knocking the lead the way you want it to go, but not too hard. After you have worked the pipe and trimmed the edges, "soil" and shave it, also solder. If the foregoing is done well—and it requires practice—it is the best way of making bends, especially if the seams are *burnt* up instead of being soldered, and not half such hard work as pulling up. Bends are known as "easy bends," "sharp bends," and "square bends." Figs. 178 and 171 are drawn from "square bends."

FIG. 178.

Fig. 178 is the bend finished; Fig. 179 is a "set off," which is really only a double bend. To make this you must make the bend, Fig. 178, first, and only solder to B, Fig. 178.

A good pipe-bender will have his work when finished with the bloom of the lead remaining, and as smooth as the pipe was before he touched it. He will not require the rasp to smooth up the edges.

Pipe Bending with one Seam.

Some plumbers bend the pipe with only one seam, which they place at the back of the bend, but this class of work is not much practised in London. Such bends can be made by slitting the pipe and opening the same, pull it round, the slit being wide open, when the throat can be worked back, or seamed part gradually worked over to form the joint.

Uneven Pipes, also Hard Pipes.

Before proceeding to explain the pulling up of bends, it will be as well to give you a few hints respecting the selection of pipe for bending. Always select that which is the softest, which can be readily known by tapping it with the knuckles. If it has a ring it is sure to be hard, as pure lead is not sonorous, therefore always select the lengths for bending which have the least amount of ring.

Before you begin bending solid pressed pipes, as before directed, always put the thickest part of your pipe *at the back*, as this part is apt to become stretched or weakened. Lead, in a good plumber's hands, may be twisted into every conceivable shape; but, as in all other trades, there is a right and a wrong way of doing everything, and there are many different methods, each having a right and wrong way, which I shall describe. I shall be pleased if my readers will adopt the style most suitable for their particular kind of work; of course I shall say that which is best for the class of work required.

Small Pipe Bending.

For small pipes, such as from $\frac{1}{2}$ in. to 1 in. "*stout* pipe," you may pull them round without trouble or danger; but for larger sizes, say, from $1\frac{1}{4}$ in. to 2 in., some little care is necessary, even in stout pipes.

Pulling Up Funnel or Soil Pipes.

In London, it is the favourite plan to make bends without cutting them. It is done without cutting or unsolder-

ing them, and is accomplished as follows: Take a sack of shavings to form the "pillow," B, Fig. 180, lay it on the

Fig. 179.

floor, and the pipe, C, on the same, but if *seamed* pipe with the seam on one side, place the back of the pipe on the pillow, with the thickest part of the lead at the back, just

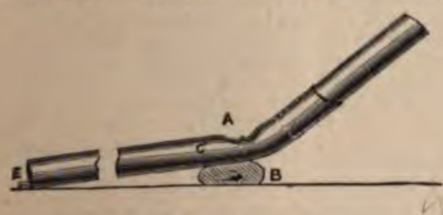


Fig. 180.

where you want to bend the pipe. Fix a block as at E, Fig. 180, on the floor, to keep the pipe from slipping; then get some dry shavings handy, and your long dummy, Fig. 181, also see F G H I J, Fig. 187, also a stick or lath to pull the hot shavings out when the lead is hot

Fig. 181.

enough; take a short length of mandrel, or a short piece of scaffold pole, as shown, put into the stand up end of the pipe, Fig. 180, just small enough to enter the

Fig. 182.

pipe, say 9 inches; having everything ready, put a few burning shavings into the throat of the bend just to get heat enough on the throat of the lead to make it fizz, which you can judge by spitting on it. When this heat is acquired, quickly withdraw the fire and let the labourer quickly place the end of the mandrel into the pipe, and pull the pipe up while you place a sack, or anything else convenient across the outer part of the throat of the bend, then pull the pipe up a little, just sufficient to dent it across the throat. Now, with a *hot* dummy, dummy out the dent as shown at Fig. 182, until it is round like the other part of the pipe. Keep at this until your bend is made, occasionally turning the pipe on its side and holding the pulled up part *forward*, to prevent it springing back, at the same time with a soft dresser giving it a sharp blow on the side, that is, when the sides run out as illustrated at B, Fig. 183. Never strike the back part of the lead from inside with the dummy, or it will be made thin, as at E, Fig. 184, but

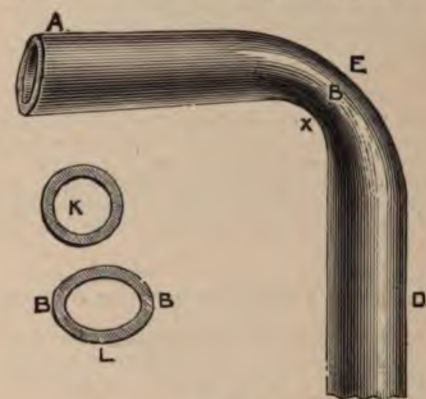


Fig. 183.

work the lead from throat to the back, with a view to thickening the back. Having dummied out the throat to its usual roundness, warm up the pipe again and pull up as before, and again dummy out the dents. Keep at this until the bend is as far round as required, remembering not to pull it too far at one time.

Bad Made Bends.

Fig. 183 illustrates a badly-made bend, and also shows how it comes together at the throat, X, and back, E; L is the enlarged section of X E, looking at the pipe endways. The cause of this contraction is pulling the bend too quickly, and too much at a time, without dressing in the sides at B B, as follows: After you have pulled the pipe round until it just begins to flatten, take a soft dresser, or a piece of soft wood, and a hammer, and turn the pipe on its side; then strike the bulged part of the pipe from X, B, towards E, until it appears round like section K. Now pull your pipe round again as before, and keep working it until finished. If you find that it becomes smaller at the bend, dummy it out, or if the pipe is too small for the dummies, take a long bolt and work the throat part out until you have it as required.

Thin Made Bends.

These can always be detected by examining them in the backs, as at Fig. 184. Take a small dresser and tap the pipe a few times round A B D, to test for the thickness. Strike it hard enough to just dent it; next strike the back part of the pipe E, *with the same force*, and if it dents much more

it is not an equally-made bend. At V W and E, is to be seen the effect of thick and thin bends, also unevenness of lead pipes. I have seen some of the much-praised London-made bends, made in what have been considered A 1 shops,

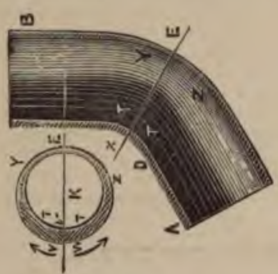


Fig. 184.

that could be easily squeezed together with the pressure of the thumb and finger. N.B.—Care must be taken not to reduce or enlarge the size of the bore at the bend.

The before-described methods of bending pipes are those generally practised, and no doubt the best known, but as there are many other methods, I will briefly describe a few of them here.

Bends made with the Snarling Dummy.

This method of making lead bends is shown at Fig. 185. This figure shows a dummy made upon a bent steel rod fixed into the bench. The method of working it is by first

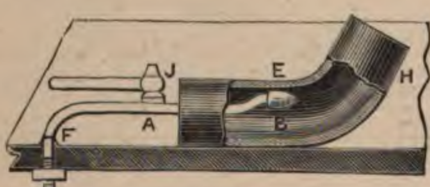


Fig. 185.

pulling up the bend, and to get out the dents, strike the rod of the snarling dummy, as shown at A, and the reaction gives a blow within the bend, throwing out the bend to any shape required. This method of working the dummy is also taken advantage of in working up embossed vases, &c.

Bending with the "Bolt."

Sometimes, for small pipe work, such as from $1\frac{1}{2}$ in. to 3 in. pipes, the cripples in the throat of the bend can be knocked up by placing the hollow of the bolt, Fig. 139, under the throat of the bend to resemble the handle of the dummy as at B, Fig. 187, and striking its back with a small hammer until the cripples are out; this is a very handy method of getting over the job [also see description of Fig. 183].

Bending with Water.

[*Light pipes.*]

It is a well-known fact that, practically speaking, for such work, water is incompressible, but may be turned and twisted about to any shape, provided it is inclosed in a solid case. The end of the pipe is stopped, and a stopcock soldered into the other end. Now fill up this pipe quite full with warm water and shut the cock, take the end and pull round the pipe, at the same time dressing the molecules of lead from the throat towards back, which will flow if properly worked.

You can hammer away as much as you please, but be quick about it, so that the water does not cool down, thereby contracting; in fact, you should open the cock now and then, and recharge it to make sure of this.

Sand Bending.

This is a very old method of bending lead-pipes, and answers for long, easy bends. Proceed in this way: The length of the pipe to be 5ft., fill and well ram this pipe solid with sand 2ft. up, then have ready a metal pot of very hot sand to fill the pipe one foot up; next fill the pipe up with more cold sand, ramming it as firmly as possible; stop the end and work it round as you did the water bend, but do not strike it too hard in one place, or you will find it give way and require to be dummied out again, or if you cannot get the dent out with the dummy send a ball through [see Bending with Balls].

Bending with Balls or Bobbins.

Not recommended unless for small pipes, and not then if the pipe can be worked without.

This style of work is much practised on small pipes, such as 2in. to 3in., especially by London plumbers. Method: Suppose your pipe to be 2in., then you require your ball or bobbin about 1-16in. less than the pipe, so that it will run through the pipe freely. Now pull the pipe round until it just begins to flatten, as at Fig. 183, put the ball into the pipe, and with some short pieces of wood (say 2in. long by $1\frac{1}{2}$in. diameter) force the ball through the dented part of the pipe, or you may use several different-sized balls, as at A B C (Fig. 186), and ram them through the pipe with a

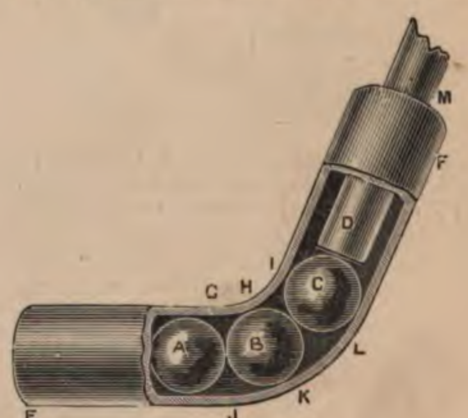


Fig. 186.

short mandrel, as at D M. You will require to proceed very carefully about this ramming, or otherwise you will most likely drive the bobbins through the back at L K J. You must also watch the throat part G H I, to keep it from kinking or buckling up; dress this part from the throat towards the back, in order to get rid of the surplus in the throat.

Some plumbers call these bobbins, dogs, balls, &c., and instead of using the mandrel D, Fig. 186, they use creepers, also sometimes called dogs; they are simply short lengths

of round wood, such as a piece of roll, &c., cut to lengths of, say, 3in. to 5in. long, having their edges rounded. The balls or bobbins will run through the pipes all the easier if "touched" over.

Set-offs, Dummies, &c.

A set-off is nothing more than a double bend, as shown at Fig. 179, and at Fig. 187, and made in much the same manner. D is the long end of the pipe. Always make this end first, and pull it up quite square, as it will be found to go a little back when pulling up the other bend; if you can make the two together so much the better, as you can then work the stuff from the throat of one bend into the back of the other. The different-shaped dummies are also here shown: F a round-nosed dummy having a flat end; both ends are very handy, the round end for knocking downward, and the flat end for pulling up, &c. G a double bent dummy,

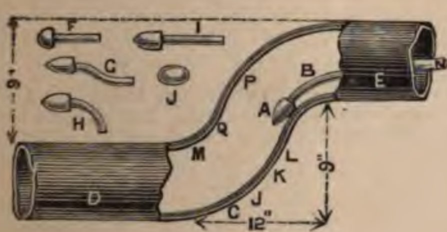


Fig. 187.

H a single bent, I straight, J hand-dummy, A B N a long bent dummy shown at Figs. 6, 7, 181 and 182.

Some plumbers prefer to make these set-offs on the bench, whilst others work them on the floor; for my part I would as lief work one way as the other, but certainly prefer the floor for pulling up single bends. Some plumbers strap the pipe to the floor when making set-offs; this is to keep it from shifting about. I prefer to make them as described in making single bends.

Twisted Bent Pipes.

This is a very good system of bending, but very little known. It is done as follows: On pulling up the bend at each operation use a cross-tree which is like the head of a crutch, this cross-tree being in length and size proportional to the pipe, the end of which is made to enter the pipe with a stop which fits into a stop cut on the end of the pipe in a similar manner to that shown at A G in the split bend, Fig. 172. As the pipe is pulled up so the throated part is twisted towards the back; by so doing the back part, or molecules, are shifted towards the throat, and so the pipe can be maintained to the same thickness throughout.

Bad Falls in Bends.

When making bends the fall should be considered, for it is of quite as much importance as making the bends of equal thickness, especially for pipes, as shown in Fig. 188. In this diagram you have a drawing of a bad bend. From A to B there is no fall whatever, as also from B to C; such bending is frequently done and fixed in and about London, which is not only more work for the plumber, but next to useless for soil pipes. It should be remembered, that the sharper the bend is pulled up the more work there will be in it for the plumber, hence, the reason why Fig. 189 is

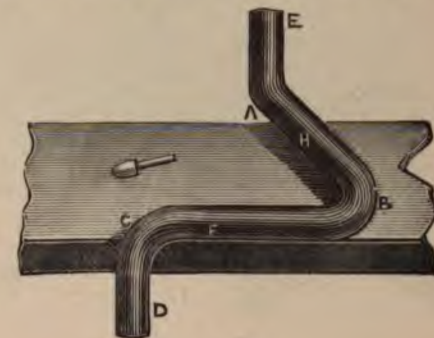


Fig. 188.

easier to make than Fig. 188, and much better for the soil, &c. Fig. 189 shows how this bend should be made with a

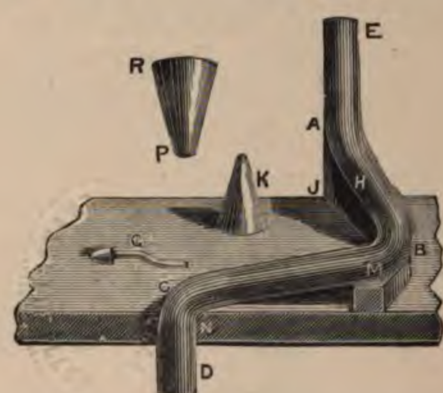


Fig. 189.

good fall from A to J, also from M to N; the method of making these bends requires no further explanation. R, P, and K are the turnpins for opening the ends, the method of which will be explained in future paragraphs on "Preparing for Fixing."

Bends made into Traps or Retarders.

It will sometimes be found requisite to retard the flow of water when running through soil or other pipes, or to direct it to another course, or even to form a trap in the length of pipe. This has been done in many ways, but Figs. 190 and 191 represent the method that I, after mature consideration, think most preferable. There is nothing new about this style of bending, as it has been long in vogue with provincial plumbers. Owing to their shape they are self-cleansing, but safe to siphon out; they are somewhat tedious to make, though by no means difficult. They are made by bumping them up whilst hot; for instance, should you make Fig. 191 hot at E F, then lift it up, say, 6in. or so, and let it drop suddenly on the end H, the molecules of lead will be driven from F towards E, and so you can thicken it to any extent you may require. Of

course you must dress in the back and throat in the usual manner. Fig. 192 is the same kind of trap, but almost unsiphonable, owing to the size of the coil, which is easily accounted for as follows: The water being urged forward by the pressure of the atmosphere, is pushed up the coil from the bottom to nearly the top; during this time when the water is nearly at the top, it breaks and allows the air to pass, when the siphonic action becomes broken and a small portion of water falls back, in sufficient quantity to seal the trap.

Fig. 190.

Fig. 191.

Fig. 192.

Fig. 193.

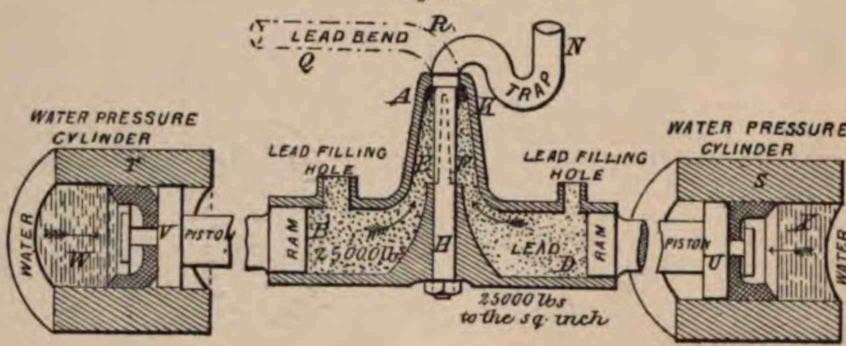


Fig. 196.

Fig. 195.

Fig. 194.

Patent ω-Traps, and Squirting Lead into Bends, &c.

The operation of forming a bend by squirting the lead through dies is somewhat similar to that of pressing leaden pipe, which was illustrated and described at Fig. 30, the difference being that when making a bend the lead is unevenly pressed towards the steel dies, which gives alternate rates to the metal whilst emerging, and which gives a converging stream to the materials. By reference to Fig. 193, it may be seen that A is a steel cone having an aperture in the top the size of the outside of the required bend, inside of which is fixed a steel mandrel, H, and which is fixed to the bottom of the machine as at C. At B D are two steel cylinders, at the top of which may be seen two separate passages converging to a point, as shown in the cross section A K, Fig. 194. These passages E and F, Fig. 193, lead up separately to within a few inches of the die. R R, Fig. 195, which is a plan, shows the top part of the meeting passages to be made zigzag, and in such a manner that the two streams of lead have their adjacent surfaces formed with alternating projections or undula-

tions, so that when the two surfaces are brought together they will be lagged into each other—a much greater area of contact being by this means obtained, which gives efficient welding to the sides of the pipe.

Fig. 196 is an elevation of the cylinders and cone. Now suppose the lot to be heated to 400 deg. Fahr., the cylinders B D filled through the filling holes with lead and allowed to solidify; now, by hydraulic or other force, force the ram B forward into the cylinder, which in its turn will force the lead up the passage E, where it will mix with the lead from the passage F (which at present is stationary). By continuing to urge the ram B forward the amount of lead from cylinder B side of the die is predominant, and emerges faster on the side A than on the other, or K; consequently the lead not passing the die in equal quantity on each side of A and K, the materials must take a curved or circular form proportionately to the extra pressure on one ram over the other. Now, for argument sake, suppose the ∽-trap, M N K, to be cut off, and the pipe with bend as shown at Q R to be required to be pressed. Proceed as follows:—The cylinders being charged for making the straight length of pipe as from Q to R, let the two rams B, D, travel at equal speed. This will (if the cylinders are of one size) cause the lead to flow forward and pass on each side of the die in regular proportions; consequently the pipe must emerge in a straight line; but now stop the ram B, and urge forward ram D; this will have the effect of forcing more lead on the right-hand side of the die, and so the lead pipe will become curved accordingly. W is the water cylinder to the ram B, and X the water cylinder to the ram D; the cross sectional lines represent the cup leathers. Of course the pistons can be moved backwards by any mechanical movements. The above system of making ∽-traps is a perfect mechanical invention.

Knuckle Bends.

These bends are not unfrequently used in small-pipe work, especially for the bosses of cocks, valves, &c. They are likewise very handy for rain-water pipes, when the pipe is required to convey water from a cesspool through a wall into a rain-water or cistern-head, as also for trapless and some other water-closet work, such as Jennings' closet and trap in one piece, or Banner's system without traps, &c. They are made as follows: Fig. 197 shows the method. Most plumbers cut the end as from A to B; others cut it as

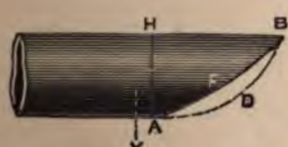


Fig. 197.

shown by the dotted lines A, D, B, and then work the end B over, as best they can.

Striking out Bends.

The proper way is first to strike the outline of the bend on the bench or floor, as at Fig. 198. X is the point to first strike the throat A from; then, open your compasses to whatever size your bend may be required, and from H, strike the back, H E, C B; take the compasses and divide the back into any number of equal parts, as at H E, C B, Fig. 198, cut the pipe to about the shape shown in the dotted lines, then place the point of the bolt or tommy, Fig.

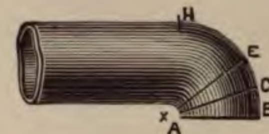


Fig. 198.

139, and with your hammer as before directed [see Bending with the Bolt], knock up the edges at A, Fig. 199. Work

Fig. 199.

this up from the throat or lip, A, Fig. 198, then take the small point of your dummy, G, Fig. 187, and place it inside the pipe at about E, Fig. 198, and with the mallet or small dresser work the point B and the sides F up to the proper shape. It will come up better if you open the sides F with your turnpin, P R, Fig. 189, or G, Figs. 12 and 109. I have found the best method of cutting these knuckles to be as that described in Fig. 199. It is done for small pipe work by first boring a hole A, and with the chipping knife cut the slit J, and round the ends off as at F, then drive the turnpin up and open the sides F K; next with the bolt make the throat or lip as shown at A, Fig. 198. Now with the small mallet and dummy work the end B, and sides F K, Fig. 199, up as that shown at Fig. 198.

Davies' Simple "Set-Offs," or Knuckle-Joint Set-Offs.

Fig. 200. The knuckle-bend may be converted into a simple "set-off" by the method illustrated in the diagram.

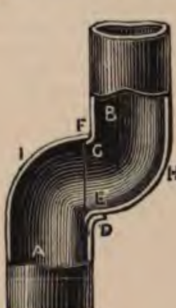


Fig. 200.

In this diagram you are shown that the pipe B enters A similar to that at E G. After preparing this for a joint, it

is finished as at Fig. 201, and makes good sound work. One thing is certain: this set-off is strongest at the part where strength is most required.

Fig. 201.

Davies' Cleansing Set-Off.

This is another simple set-off, made either with a bend or knuckle-joint. This set-off has a cap and screw, H, Fig. 202, for cleansing the soil-pipe. This requires no further description, and its working is all that is required at about one-fourth the cost of labour in making ordinary

Fig. 202.

set-offs. I am pleased to say that these are the ***first on record.***

TRAPS.

Traps.

Now we have concluded the subject of pipe bending, we may as well proceed to make up S-traps, which is nothing more than bending; after which I shall proceed to instruct you in the making of every kind of trap generally used by the English plumber.

Definition of Stink Trap.

This is simply a device for preventing vapours passing a denser body. The latter may be understood to be a liquid body, and the former a gaseous, but not necessarily so.

General Opinion on Traps and their Use.

There are in the market scores of different traps, and each maker claims to have the most efficient one, but it is clear that they cannot all be best. For my part, I do not take notice of any one's opinion who may be interested financially in the manufacture of them, as within the last three years we have seen, and which is universally acknowledged throughout the trade to be so, that such opinions are anything but impartial; and as I am in no way interested in the manufacture of traps, I can give you what I consider to be an unbiassed opinion, which is as follows, namely, that a house having closets fitted up with water closets without some kind of trap cannot be healthy; and I further say that, after nearly 30 years' practical experience and carefully watching the action of traps generally, I am thoroughly of opinion that the new pattern D-trap (which is or can be made by every plumber), for its general use under valve closets eclipses all others in the market, though, for my part, I personally can make almost any trap answer. After this, let it be thoroughly understood that I shall not in any way try to bias anyone from using a trap which he may fancy. Of course, I shall show the action of D, S, and other traps.

Stink Traps and their Varieties.

Stink traps, as you will see by the "alphabetical list," have many titles. I do not pretend to treat of half the number of names known, but only those in general use. There are the Anti D-trap, Antle trap, Bag trap, Balance trap, Ball trap, Bath, Running or Belly trap, Bell trap, Bottle trap (Davies'), Bowl and Pipe trap, Branch trap, Cistern trap, Circular trap, D-trap, Davies' London closet trap, Dip trap, Eclipse trap, Electrical trap (Davies'), Fat or Grease trap, Flap trap, Float trap (Davies'), Flower-pot trap, Gully trap, Half S-trap, Hunch trap, Intercepting trap, Inverted Cup trap, Knott trap, Lip trap, Mansion trap, Mansion D-trap, U-trap, Pressed up traps, Running or Bag traps, S-trap, Semi D-trap, Siphon trap, Side trap, Signal Alarm trap, Sink trap, Soap trap, Three-quarter or cut down D-trap, Straight pipe trap, V-trap, Ventilating trap—all of which have been made of lead. The above are only a few quoted from memory, and are only a portion of the multitude, and yet nearly all are subject to, and dependent upon, the same law of action—viz., the water-seal. We are told that Glauber, the old chemist, knew the value of the water-seal, or Stink trap, and I quite believe he made use of what we now call the Bell trap, as a water-lute or valve for arresting his chemicals or gases, and to this day we, together with the best chemists of the land, are glad to use this simple contrivance as a governor or check against mephitic gases.

The simplest made of all traps for sanitary purposes is that known as the bowl-and-pipe-trap, formerly used for rain water-pipes, sinks, bath wastes, &c., &c., especially when these pipes empty themselves into the old-fashioned "brick-trap." I have personally, about 20 years ago, taken six, or in some instances, ten such ends of pipes, into one bowl or cistern.

This trap is neither more nor less than a bowl of water, having the end of a pipe dipping into it as at B, Fig. 203.

Here you see the bowl A, which may be made to any shape (round bottom is best) and of any material (in the olden days it was of lead); now it is not unfrequently a common flower-pot with some Portland cement dropped to the bottom.

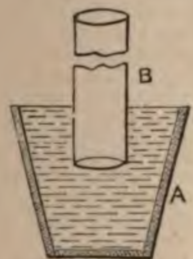


Fig. 203

I must ask my readers to take notice of this trap, as I think it was the first step towards the invention and adoption of the well-known D-trap, the history of which I can trace for at least 205 years, a drawing of one of the oldest of which I here append, taken from a photograph.

Fig. 204.

A Bi-centenarian D-Trap.

Fig. 204 is a correct drawing of an old lead D-trap, which although over 200 years in constant work, is in a very good state of preservation. There is something very remarkable about the make of this trap: the bottom near B is quite ¾in. thick, whilst the other parts are only about 7lb. lead.

I may here mention that this trap was taken out of Lothbury Old Church (Sir Christopher Wren, architect), so that my reader will be able to judge for himself.

Half S-Traps.

Fig. 205 is the ordinary half S-trap, wrongly called D-trap. It is nothing like the D-trap, as may be seen by reference to Figs. 204, 252, and 254, which are correct

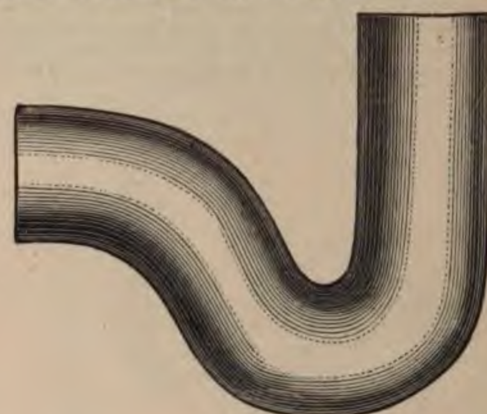


Fig. 205.

representations of the real D-trap. The S-traps are properly called "siphons," and have always been known by this name. I should here remark that Apollodorus called a tube of this shape a "sipho."

The ancients made aqueducts of a siphon shape for conveying water through valleys, and in Claudius's reign they were used in the city of Lyons, but traps, I have no doubt, were invented for gaseous purposes by the chemist. This trap is made in various ways, some being cast in one piece in moulds, something like the pipe moulds, having the core in a lot of pieces, and known as jointed cores, which can be screwed or wedged together in various ways. The inlet end of the core is sometimes made a fixture, the outlet end is made to draw out on slides and with levers; also, the two sides which form the outsides of the trap are made to run on slides, which are also worked by two levers: the trap may be cast as follows: Suppose L M, Fig. 206, to be a mandrel fixed upon, say, an iron block or frame, C D part of the trap now being at the top, or inverted. Now have a core, K A, made to run on a slide which is so arranged that it may be worked backwards and forwards into the trap, the bottom part being in smaller pieces. Having made this to work, make the mould to form the sides, to also run on slides, and in such a manner that they will open and close with levers. Then, with gas, heat the mould up to about 500 degrees Fahr., and when hot, with some good pig lead, from the bottom part of the trap at D, run the mould full, the runner being of a somewhat long narrow opening; having run the mould full to excess, quickly pull out the outlet mandrel A K, open the sides; then, with some leather and padded gloves, quickly pull the trap off the inlet core, and trim your trap ready for the market.

Whatever method the mould is made for solid cast S-traps, it requires a lot of heat to keep the mould going, which is one of the secrets of the casting. Of course, the metal must be kept clean. I shall refer to hand made S-traps, which will always be wanted to suit the different kinds of work. I will enter upon the subject more especially as it is good practice for the young plumber. The half S-trap, Fig. 205, is simply a curved pipe, or tube bent in such

a manner that it will retain sufficient liquid to bar the passage of lighter fluids. Amongst plumbers it is known as a trap, but how long such traps have been in existence no one can tell. They answer for many sanitary purposes.

The above pattern, although much used, is faulty inasmuch as that the outlet curve is too easy for valve closet work. I never use them for this purpose. Fig. 206 is the same kind of trap suitable for sinks, &c. Here the trap is fitted with the cap C and screw D for cleansing purposes. When this cap and screw are used under sinks, it is often best to put it on at the side, so that it may be more readily got at when it is required to be undone.

I have said that Fig. 205 is faulty in shape by its out-go

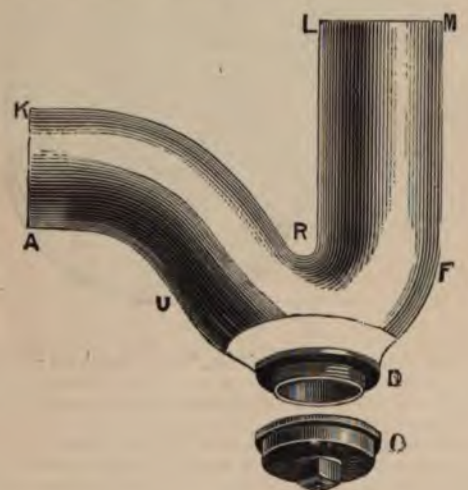


Fig. 206.

slope being too easy, but by examining Figs. 207 and 208, which represent hand-made traps, and are of the proper shape, it may be seen that its out-go is sharper at the throat and back.

Fig. 207.

Fig. 208.

The above hand-made or sheet-lead trap is used, comparatively speaking, all over the world. I shall now proceed to explain the method of striking the form of these traps geometrically, and their making by hand.

Traps.— ∽-Traps, Striking, with Easy Outlets.

As there are often unpleasant arguments respecting the shape of ∽-traps, especially with plumbers of different neighbourhoods, I herewith give a geometrical method of striking out the only true shape for these articles.

For a 4in. trap open the compasses to about 1in. so that you may strike the half-circle, R W X, Fig. 209, then draw the right line, U Y, cutting the point Z. Now open the compasses so as to strike the bottom arc D Y U, which must be 5in. for a 4in. (the size of the trap) from the throat line W to D. Next draw the line B C parallel to U Y, and cutting the bottom or belly of the trap at D; then take the compasses with the radius Z D, and from a point on the line B C, strike the outgo (shown on dotted line) T Q, cutting the neck of the trap as at Q; this forms an easy outgo. Open the compasses, and with a radius of B to R, strike the top H R, cutting the throat at R. This will give a 1in. dip water-lock or seal. Next draw the line K B, cutting the point B, and perpendicular to B C, which will give you the square line for the outgo; but should you require more water-lock, then, instead of striking the neck as per dotted

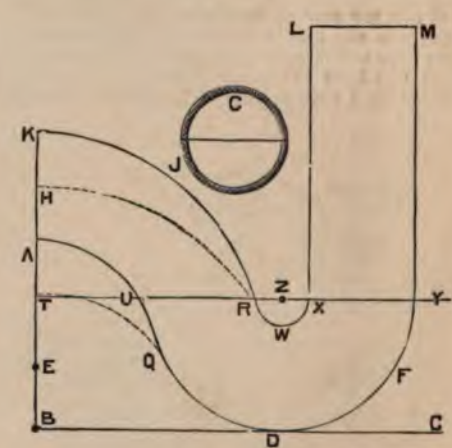


Fig. 209.

line, go higher up for the centre, as at the point E, and with the same radius (Z to D) strike the neck line as at A U Q, and open the compasses to R for the top line K J R. which completes the pattern.

I have lately made some experiments with these traps, and find that 2in. water-lock is better than 1in., owing to this kind of trap waving its water-lock away, especially where well ventilated. I have given this diagram a water-lock of 3in., which, to a great extent, gets over the difficulty of momentuming out; but this extra dip is greatly against the action of the trap for self-cleansing purposes, as the soil must take a great dive before it can reach the outgo.

Fig. 210 is a geometrically struck ∽-trap proper. First draw the lines A A, B B, and V V. V V should be the dip of the trap, namely, 1in. from R to C. Next from R drop the half-circle C, with the compasses open 1in. wide. Then open the compasses 5in., and from the same point strike the bottom of the trap, cutting the line A A and B B as at D. Then with the same radius as the throat circle C, 1in., measure from W along the line V V as at X, and strike the half-circle U. Then open the compasses 5in. and strike the

top line Z, which will cut or meet the throat circle C, and the line at A. Next set up the lines L M square to the lines A A; also the line N and the line 1 and 2 square

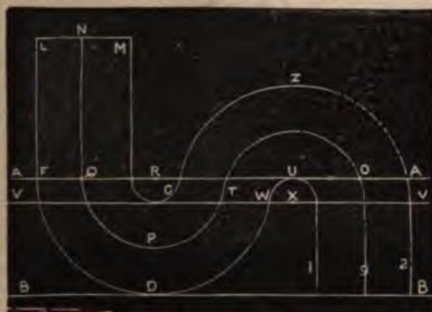


Fig. 210.

to A A, and the trap is complete. The centre line P is drawn similarly to the outside lines.

Making ∽-Traps by Hand.

For systematical work you will require a block which is best made in two halves, see fig. 210, the middle line N Q P T O, 9 represents the parting line. Having your block made of wood or iron, first measure off round the trap from end to end, and also the circumference; for a 4in. trap say the lead should be 13in. wide, but in two pieces with planed up edges. Now take and bend back the lead the distance from the throat to the inlet; after which take the mallet, or bossing-stick, and work it from the inside of the lead to the shape of the throat; then "offer" it on the trap block and fix it at the end with the clamp ring A, Fig. 211. Next bend it easy up to the outgo as at Z A B, Fig. 210, and fasten with the other ring.

Fig. 211.

Work down the sides from O to T, Fig. 210, also the other side as easy as you can so that it will just come in the centre of the trap. Next take this off the block, and take the bottom piece of lead and with the mallet round or hollow it to fit the bottom, and put it on the block and bend it up to the inlet, fix it with ring and finish it to an equal thickness throughout and without cripples by working the lead gently the way you require the molecules to go, and prepare for burning or soldering up; if the latter, wiping is best, with a rounded back joint like that at R D, Fig. 229. If copper bitted together let it appear like that at Fig. 207.

Anti D-Trap and Trap Junction.

Fig. 212 illustrates a thoroughly good and reliable trap, proof against the great evil of waving out or water momentum. This is of the greatest importance, for do what you will ventilation is totally useless against this nuisance, and which for ever must exist in all-round pipe traps having easy curves similar to that shown at Figs. 205, 207, 238, 264, &c.; also see Trap Testing, page 121.

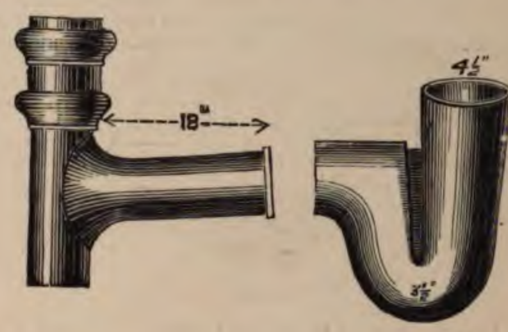


Fig. 212.

Fig. 212 is the latest improved closet trap with a taper inlet large enough for a full-sized 4in. valve closet box; a great consideration in fixing closets. This inlet tapers down to 3½in. at the bottom, and has a 1¾in. water seal with elbow top, and has a 4in. round pipe outgo A B.

On this trap may be had, *cast on* or separate, a capital stout lead junction or branch pipe, having a cast joint to resemble a plumber's wiped branch joint with socket and astragals to match ordinary 4in. iron stack pipe.

PRESSED-UP TRAPS.

∽-Traps.

Within the last few years they have been made by hydraulic pressure—*i.e.*, pressed into their shape by a method somewhat similar to that adopted in making lead pipes [see Lead Bend Making by Hydraulic Pressure, Fig. 193, and description]. This method is undoubtedly the best, inasmuch as the lead is, as a rule, much more solid than when cast.

The Running or Belly Trap.

This, though known as the running or belly, is actually the siphon [see Fig 213]. I have been able to trace back siphons for at least 3,400 years, and it is beyond dispute that they were well known even before that date.

As an instance of their antiquity we have only to quote the words of Pliny. He says:—"Water always ascends of itself at the delivery to the height of the head from whence it gave receipt. If it be fetched a long way, the water will rise many times, but the level of the water is still maintained." Figs. 213 and 215 are belly traps, perhaps in an improved form. B is the inlet, which, please notice, has a drop or cathetus from B to the water-line S. This is the subject of a patent by Mr. W. P. Buchan, and it is most effectual for pushing forward solid substances, owing to the law of falling bodies accelerating in proportion to the space travelled—*i.e.*, suppose the depth from B to the water-line S to be equal to the depth of water within the trap, then the momentum gained will be of equal force to press this forward. Students in mechanics will find some exemplification of this law in the first lessons of mechanics by that item known as "the two balls showing reaction." Fig. 213 represents a long trap-body, which holds more water than a trap made after the model of Fig. 214. The latter, by reason of its size, may be considered the best, inasmuch as that the whole of the water

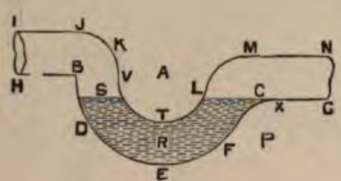


Fig. 213.

can be easier changed than it can be if as at Fig. 213, but Fig. 213, being of a more gradual slope outward, solid substances will have a better chance to get away. But let us again refer to the subject of the trap being made to quickly empty itself.

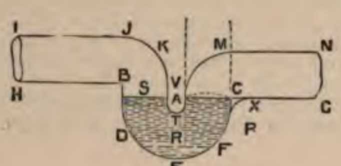


Fig. 214.

This is important to a degree from a sanitary point of consideration, as in all traps the whole of the water should be changed, if possible, for the very simple reason that the longer water is exposed to poisonous gases, the more it becomes imbued with the poison, and consequently the more injurious it becomes to the health. This useful little trap

Fig. 215

is very handy for bath-work, as it gives a chance for the trap to be fixed between the joists. The trap is made as follows:—Take the size, and at the throat bend the lead right back, so that the two ends meet (but do not make it too sharp at the throat, or it will cripple and break); then with the mallet, &c., work the throat from the inside part of the lead, so as to form half the pipe at that point; then work back the bends, J K M, and make the bottom, which is easily done after making the ග-trap.

Fig. 215 is an illustration of the trap above described, which shows that it is made in two halves, and soldered or burnt up.

The Hunch or Bag Trap.

Fig. 216 is a hunch trap suitable for fixing on an upright pipe, and requires patience when making it; in fact, I have purposely kept this for the last of this class of trap, in order that you may all the easier work it. You will perceive that the hunch is all on one side, but they are made to suit the different places, and are very handy for fixing in brick chases, &c., suitable for such works as rain-water pipes, sinks, wash-basins, &c. When beginning to

Fig. 216.

work this hunch trap, Fig. 216, up, first make M U Q A P, and fit W S J F E G K to it. It should be noted that when you have no block to work to, in all cases draw the shape of the trap on a bench or drawing-board, &c., which you should be able to do easily after what I have explained to you on the striking out of ග-traps.

You must be very careful to work the first piece, M U Q A P with great truth to your set-out lines, more especially round the part Z, and be careful not to get it *too small* for the top part to fit into.

Circular or Knot Traps.

For circular traps, see Bends made into Traps or Retarders, Figs. 190, 191 and 192.

SLOPPING-OUT TRAPS.

(Making).

Valve Closet Overflow Traps.

These are made as shown at Fig. 214, with the inlet as per dotted lines M; they are made from 1½in. to 2in. diameter, in chill moulds and the core slopped out, as follows:—Suppose you to have the mould or outside shape of the trap in cast iron, properly dowelled together, the one end solid or stopped up. Place the mould together and fill it from the other end with hot lead. Now quickly turn the lead out; the core or unset part of the lead will run out. The outer part being suddenly chilled will give the desired trap. Any decent plasterer can make your moulds, which you can have recast in iron.

Having explained the making of ɷ and other traps of this kind, I will now explain a few more which I have dropped across, and which may be useful to you during your odd work.

The Kensington Trap.

Fig. 217.

Fig. 217 is a trap suitable for all classes of work. It combines the good properties of the D, S and P, viz., it cannot momentum or wave out, nor can it under ordinary conditions be syphoned out. It is a trap likely to take the place of those heretofore used for valve closets.

Sutcliffe's Cast ɷ-Trap.

This trap has been cast with cleansing-cap, and screw J, Fig. 218 on top of the outgo. It has also a tie, Z,

Fig. 218.

across the throat, to prevent its being pulled out of shape This trap will not momentum out. [For this see my Trap Experiments.]

ɷ-Trap made in Three Pieces.

This is a very old method of making ɷ-traps: the bottom Q D F, Fig. 219, is cast, the dip M L soldered or burnt on, as also the outgo A Q J. Fig. 219 is a drawing of a trap

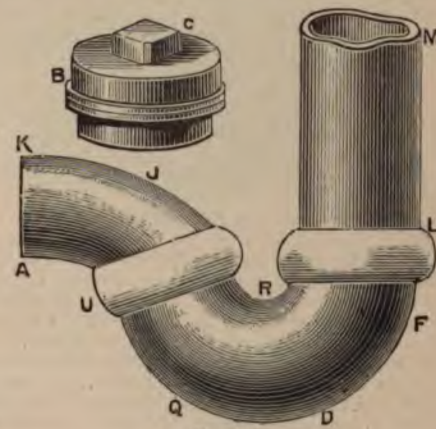


Fig. 219.

weighing over ¾cwt., lately taken out of an old house in Knightsbridge.

Traps in Two Pieces.

Sometimes you can make a trap to suit your work by simply soldering two knuckle bends, as at Fig. 198 together, and by branching in the outgo, as shown at 1, 2, 3, 4, 5, in the diagram, illustrating Bostell's closet, Fig. 576 [see my Closets Work].

ɷ-Trap with Lugs for Fixing above Floors.

Fig. 220 is a diagram of an ɷ or half ɷ-trap for fixing above floors, suitable for short or low balloon basins.

This trap may be made with cleansing cap and screw, and can be wiped down to the soil-pipe at A, or on a

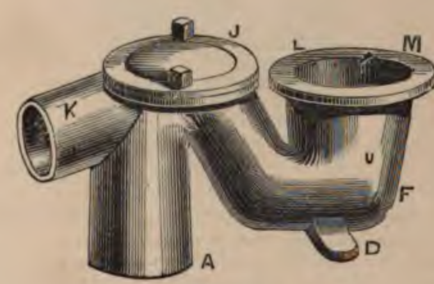


Fig. 220.

straight outgo. This style of trap has been made in iron for prisons, also in earthenware, but the difficulty has been to make the connection with the lead and outgo sound. This difficulty has been overcome by making the trap with a flange on its outgo, and also of lead instead of earthenware.

The Semi D-Trap, Fig. 221.

This is another trap for fixing above the floor line, and excellently well it answers its purpose. The bottom part,

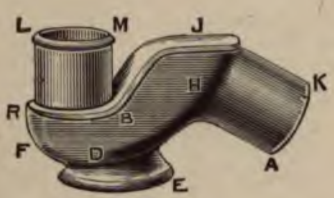


Fig 221.

D H R, of this trap may be bossed up on a block or otherwise, and the top or inlet soldered on, so that the lower part R B forms the water lock. The dip may be wiped in, in the usual manner and may be flanged on the top or let through to the required depth to form a water seal, say an inch or so below the top part, which prevents its losing its water lock so easily as it would otherwise. A cap and screw [B C, Fig. 219] may be fixed on the top of the trap at J. The foot E is also soldered on. Of course this trap can be fixed below the floor-line with the outgo soldered on in the usual way. It is an excellent trap for closets.

Three-Quarter or Cut-Down D-Trap,

[*Sometimes called a* V-*Trap.*]

The title of this trap will explain for itself that it is a modification of the D-trap, or rather that, owing to inconvenient circumstances in fixing, the D-trap has had to be slightly altered to render it suitable for its confined or awkward position. To meet these trying circumstances it is sometimes necessary to cut down in the following manner :—

[See V E, Fig. 222.] In instances where you can go down 1½in. or more below the outgo, we *sometimes* do away

Fig 222.

with the dip, and the trap is doubtlessly useful in many places where the ordinary D-trap cannot be used. You will see that this is a modification of the D-trap into a kind of V S-trap, the inlet side being simply a round pipe merging into a square pipe on the outlet side. They were very common from about the year 1840 to the year 1860, when they seemed to go out of fashion, but revived about the year 1878. I wish to draw your particular attention to the making of V-traps, as some of our sanitarians are very much taken up with this particular trap for fixing below water closets, and are recommending this shape of trap anti D; therefore it will be all-important that you should know the simplest and best methods for making them to suit your price and the different places. Of course the dip part of the trap may be wiped on the cheeks or body as at E, Fig. 222, and may be made to any size; but 3 inches water way between the dip and band as at Z will be ample, and say from 4 to 4½ inches wide; in fact, if you wish it to be entirely self-cleansing the dip pipe, which should be 4½ inches at the top, should be made cone shaped to about 3½ inches at bottom, as at E, Fig. 222, and the remaining part of the body from E to G to have a square water-way of not more than 3½ inches, the outlet across K being about 4½ inches wide. In the year 1878 I made and fixed about 18 of these traps, being only 7 inches deep, which are fixed below pan closets for Mr. Hurst, of Barnet, and which upon my examination some few weeks since were found to be as clean inside as a round pipe trap, and which have given perfect satisfaction since the time of fixing.

Before you proceed to make the V-trap you should well practise making the D-trap, therefore proceed to my explanation upon the same before attempting V-traps, but as the order of V-traps follow the S-trap I must describe the V-trap first.

V-Trap.

This trap, Fig. 223, often called the mansion trap, is not so good as the D by reason of the siphonage. Its action is exactly that of the S—in fact, it is nothing but the S made in another way, more roomy, and square from the dip part to the outlet instead of round, which allows the soil a better chance of exit under the throat. As, however, my work will not be complete without giving all the general shopwork, I cannot let it pass unnoticed, more especially as it is rather good practice work. I have shown this trap three different ways by one figure in order to save space. For striking this out for a 9in. open the compasses to 4½in. and strike the circle A, then draw the top line B, then the heel line E square to B, then measure off (with the compasses) the length of cheek—that is, the distance from the heel point E to the extreme point E of the circle between A and C; then, with this distance, measure off along the top from heel E to outgo point R; then with your rule or straightedge draw the outgo line T. Next, get the dip-line VV, which should not be for a 9in. trap less than 5½in. from the top line, or 3½in. from the bottom of the circle A, and round at D, so that the lead can be bent round easily. This will give plenty of room for the soil to pass, as the trap is 6½in. wide; next draw the throat line W either 4in., 5in. or 6in., from the outlet point

Fig. 223.

R, mark off along the top 4in. and draw the V line, and the cheek is complete; but should the trap be required to be made 8in. deep, which is better from a sanitary point of view, then draw your circle 8in., and so on accordingly.

But if the trap should be wanted with the D outgo,

then draw the line C, and with the 4½in. radius strike the arc F as in the U-trap, for which see Figs. 252 and 253, and the trap is completed. Next is the band, which you can make without explanation; but the top is quite different. The top at times is cut to the shape of Fig. 224. B is the part for the inlet if so wanted, C the throat part, and A the outgo end, which must be made long enough to reach to R, Fig. 223.

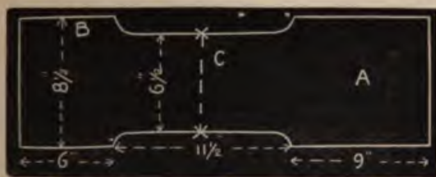


Fig. 224.

Fig. 225 also illustrates the cheek, and the method of striking this cheek out without making the outlet F rounded &c., as at H.

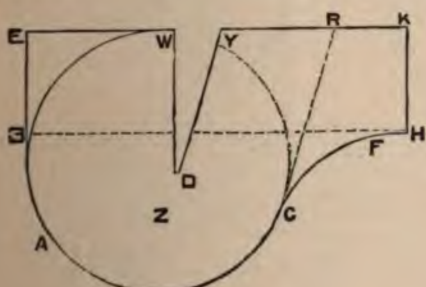


Fig. 225.

Preparing for Soldering.

Having the lot cut out, let us prepare for soldering up as follows: Soil the internal part of the trap cheeks, then shave the inside of the cheeks and band, and solder this up as in the D-trap, Figs. 248, 249 and 250, further on. Next, shave the inside part up the throat and inlet, and then round the outside of the inlet and top of out-go, as if you were shaving for the D-trap (it will be all the better if you rasp all the very sharp corners off, as at W Y, and have the throat rounded ½in. at D). Next shave all round the top, Fig. 224, the usual width. After all this lay the trap body on its side in such a position that the top will overhang the block about 1in., then take the top and measure off exactly the distance from the corner of top body and trap at W, and with this bend the top to suit. This will be at the two stars and dotted line. Remember, the lead must be bent right back. Then place it in the V of the cheek and fix with nails, as in the D-trap; this done, wipe this side out, but be careful not to leave too much solder at the corners, W and Y, to be in the way when the top is bent back. This done, solder the other side, after this bend over the top, both the inlet and the outgo parts, and solder them up. Of course, if you want a short outgo, then cut the cheek as per D-trap, and as shown at R, Figs. 223 and 225; if long for a U, make it accordingly. Take particular notice that, when soldering up this trap, or anything else, that you beforehand make a bradawl hole in the lead somewhere, in order to admit the fresh or cold air as the metal cools; otherwise you will have your work drawn or pressed into all shapes. Fig. 226 illustrates the trap after it is soldered up; the pipe L, M, is simply wiped on the top, V, W, or instead of this top being wiped on as at E, it may be wiped on at the white line near Z, &c. E R is the soldering, T Z the dip or water lock, J the top for cap or screw if required, G K the outgo.

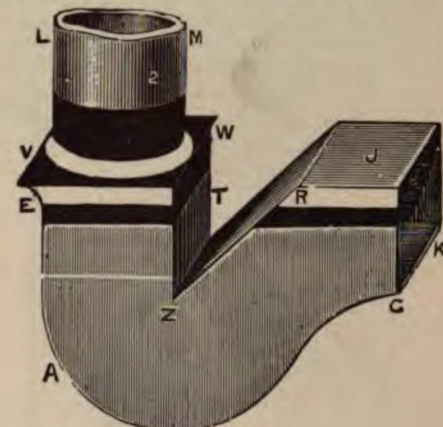


Fig. 226.

Fig. 227.

Fig. 228.

Figure 227 and Figure 228 is the latest improved 8lb lead trap in the market. The advantages of such can readily be seen by a practical workman. It is impossible to momentum it out, and will take from 2½in. to 4in. gratings.

Old D-Trap.

This trap [Fig. 229] has stood its ground for at least 200 years, and there can be no doubt it had its origin from the dip pipe and bowl trap [see Fig. 203]; then to the shape of the U-trap (to be explained shortly), then altered again to the shape shown at Figs. 229, 230, 233, and lastly, to its present shape, Fig. 244.

But, in whatever way this trap first originated, there cannot be a doubt that it has lately got into sad disgrace by being badly made by duffers and with many who do not know its merits.

The D-trap has been made by many plumbers, who never thought it was wanted for anything more than the keeping back of stinking puffs of wind or air, sewer gas, &c.; they have made it to almost any size and shape, not troubling or caring whether it cleared itself or not.

Fig. 230 shows the same kind of trap taken out of old Campsbourne House, Hornsey, which is as near as possible 110 years old, and in a good state of preservation. You will notice that the *cheek* C and the *top* are in one piece, and that it is in shape of a true D. It is soldered on from the outside. The Fig. 231 represents a plan of the band, and Fig. 232 the cheeks and top.

I am inclined to think that it is by far the better plan to wipe traps up all from the outside, the advantage of which

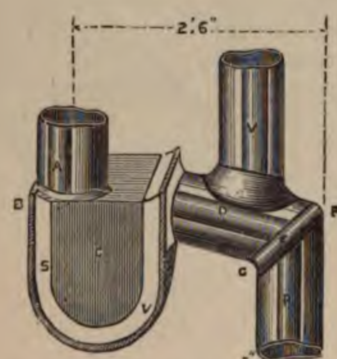


Fig. 229.

Fig. 231.

Fig. 232.

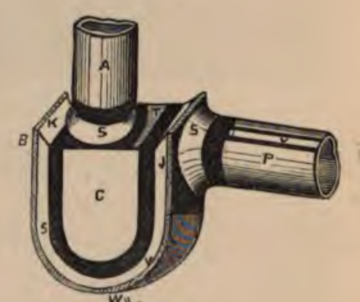


Fig. 230.

I shall show the best method of making it so that it shall be what is generally known as self-cleansing; at the same time I shall keep within the bounds of that principle which, I suppose, is universally known to be the beauty of the D-trap—viz., the clearing the soil from the inlet to the body of the trap, and its retaining the water-seal or lock, especially against the siphonage momentum or waving out caused by strong currents of air blowing down air-pipes or up soil-pipes.

In Fig. 229 I have given a correct illustration of an old trap taken from Twyford Abbey. This trap was fixed under a marble closet basin, with the rain water pipe V,

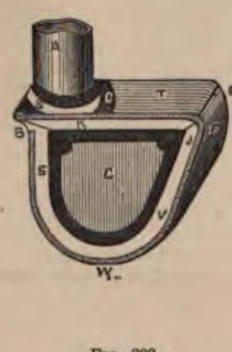


Fig. 233.

which acted as a ventilator; the trap is quite perfect, except that it is fouled about the dip, and from what I can glean there is very little doubt that the trap is upwards of 200 years old. It is curious to note that the outgo elbow of this trap, instead of being cut half or three-quarters through at the elbow-joint E, F, G, is cut all round, and the joint wiped round it; the pipes are wiped up at D P V and at A, and it is a bit of very good plumbing. The band and top are one piece.

is shown at Fig. 233, where it is quite evident that all the solder is in view, and accordingly can be seen after soldering on the outgo at F J.

Another advantage is that you will have a much wider flange to wipe to. In the case of the trap being only wide enough to admit the dip, it is best first of all to solder the band to the two cheeks, then bend it over the top, and wipe it round, as shown in the illustration; fix the dip last of all.

Elevation of D-traps with Top and Band in One Piece.

This is illustrated at Fig. 234; at the outgo the band and the top is shown to be in one piece, as also at E F, Fig. 233.

Fig. 234.

Cast Lead Round-Bottom D-Trap, with Flat Outgo (Helmet).

Pullen's New and Improved Patent D-trap may be had with a round bottom and flat outlet. The object of the

rounded bottom is too well known to require any comment here. Suffice it to say that this trap (which is now made according to my scale for the D-trap), is not only self-

Fig. 235.

cleansing, but proof against waving out. It is very easy to fix, and, in fact, possesses every qualification that is required, and constitutes a good sound trap.

Fig. 236.

Fig. 236 is an elevation of the D-trap, having a cleansing cap and screw C soldered into the side or cheek; this latter being fixed here, is more for sink work than for closets; in fact the proper place for this cap and screw for closet-work is at I. In order to get at it I have made D-traps with the dip to screw in and out, but for sink-work it is best to fix the cap and screw, as above shown, at the side or under the bottom. This allows you to take such things as tooth-brushes, &c., out of the dip, which cannot pass into the body of the trap.

[For elevation of the cap and screw refer to B C, Fig. 219.]

Now we are speaking of these old traps, and before I proceed to explain the making up of D-traps, I should like to draw my readers' particular attention to the much-talked of sewer-gas corrosion, which prejudiced people seem to think is only to be seen in the D-traps.

It is a well-known fact that sewer gases act upon almost every kind of metallic substance, and without here going into the theory (but which is explained in other parts of this work) of this corrosion, I wish to refer my readers to Fig. 237, which represents an unventilated trap, which has not been in use more than thirteen years, and which is most completely corroded (owing simply to the fact that there has not been any ventilation) at all points above the water-line. [See the dark spots at A, B, Fig. 237.]

Many persons are under the erroneous impression that this corrosion arises in consequence of some impurity in the material of which the trap is made, or, in other words, that the lead is not of good quality; some others will argue that the evil is created by the use of some of the disinfectants now in the market; but neither of these arguments have much value, as the real cause of the corrosion is the action of the sewer gases, and the waters used in connection. Of

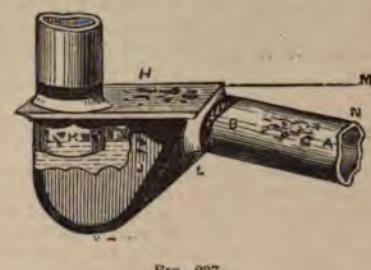


Fig. 237

this I have sufficient proof in the one fact that the trap from which this drawing is made is one of a set of eighteen in different houses, and each one is in a similar condition.

Mr. Pullen has suggested that it is caused from the use of thin or inferior lead. I must disagree upon this point, for, be the lead thin, thick, pure, or impure, sewer gases will and must attack it, and create corrosion, unless there is sufficient effectual ventilation to allow it to escape. A very satisfactory proof of this may be obtained by taking one of Beard and Dent's traps, Fig. 238. These traps—though I have heard some persons in the trade dispute it—are made of pure pig lead, and, in fact, there are very few workmen clever enough to cast them from anything else. It has been argued by some plumbers that they cannot be "pure pig" because they cannot open them at the top without splitting. I, however, can and do, so that I fancy the fault is with the workmen, not the lead. I have had occasion to use a great number of these traps in various parts of the country, and have burned them into the outgo, instead of making the joint D, Fig. 238. This alone is enough to prove to me that the quality of the lead is beyond dispute, but for self-satisfaction I have just, previous to penning these lines, applied one of the most definite tests as to the quality of the lead, viz., I have cut one of these traps asunder at J K, and burned it together; this, in my estimation, is a definite proof that the lead is pure, or it would be scarcely possible to do it.

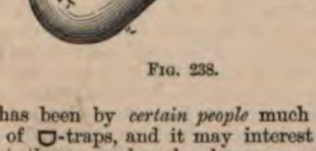


Fig. 238.

There has been by *certain people* much talk about the corrosion of D-traps, and it may interest my readers to know that these people who have so eagerly tried to condemn this trap because of the corrosion, have never in the least been found to speak of the corrosion found in the S-traps, which are made of the same material, and which are found corroded precisely as in the D. Now, why is

this, when we know as a matter of fact that the two traps are made of one and the same material, and the gases from the sewers, drains, &c., have precisely the same action upon the ∽ [see the much eaten or corroded parts at A, B, D, C, or the dark spots, Fig. 238] as upon the Ʊ, not losing sight of the fact that the formation of the trap has in this case nothing whatever to do with the chemical action originating from sewer gases? Here is a paradoxical question for these persons to solve, and I defy them to substantiate the veracity of their statement that the Ʊ-trap is bad, if *properly constructed*. They know that I am only writing that which cannot be upset if *facts* are the points in the argument.

Geometrical Ʊ-Traps and Cutting Out.

Fig. 239 is a geometrical system which I have worked out or invented for the purpose of always having a good shape. "Perseverance is the bridge by which difficulty is overcome," for we read that 80 years ago the mania for striking this trap was considerable, and it was not until I had worked away at it from 1858 until recently that I could do it, although it is so very easy. What I have done is simply this. I have found the geometrical method for making the pattern to one shape large or small, and, there-

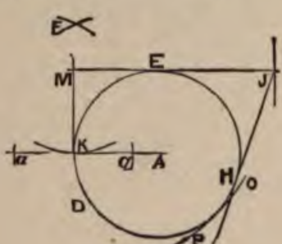


Fig. 239.

fore, we shall not want to borrow from a good-shaped trap when we see it. I have known the time when I would have given a sovereign for a trap pattern.

Fig. 239 shows my geometrical plan for striking out the cheek of a self-cleansing Ʊ-trap. The novelty of striking this is in obtaining the point J, so that it will make the same angle in any sized trap—viz., the angle of 76°, for proof compare the above figure with Fig. 240. For striking the above cheek take a piece of lead, having one straight edge, as from M to J, open the compasses to, say, 4½in., and scribe the circle D E H, cutting the line at E. Now if you have no square at hand, the heel line may be obtained as shown by the above illustrated method by first setting the leg of the compasses on the line E, say at M, and with the same radius as the circle E H D was struck with, as from M to K, strike the arc K, and draw the line *a* A, cutting the circle point at A. Now this will divide the circle at K, and from this point, with any distance, set the points *a*, *a*. Now from these points as centres, and with any distance or radius of the compasses, strike the intersecting arcs F, and through this centre draw a right line, cutting the top line of the trap, and also the periphery of the circle, as at K, which will give you the square or heel line of the trap. Next, and most important, place the point of your compasses at the intersecting point M, and with the other obtain the distance to the outside point of the circle, as at H, and as shown at O P arc; then, having obtained this exact distance, set it off along the line M E, as at J. This is the length of the top. Next from the point J draw the outgo line J H, and this will be the proper angle to allow the water to rush and sweep everything from the dip, along the bottom of the band, and out into the soil-pipe. Having learnt the above method—Next, to strike this trap cheek out as quickly as we are thinking about it, take the compasses, open them to 4½in., strike a 9in. circle [I, Fig. 240], cutting the top line J. Then take the square, and from this line draw a square line, or the heel K, cutting the circle at L; then with the compasses measure off the distance from the heel point E to the extreme front point of the circle, as at N; then this distance is the length from the heel E to the front point of the cheek, as at F. Next with your rule or straightedge draw the line P, cutting the extreme outside of the circle at N, and the point at F, and the cheek will be perfect.

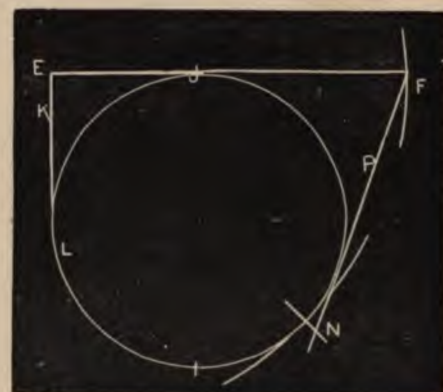


Fig. 240.

The next thing to be considered is the depth of this trap for self-cleansing purposes: this is governed by the size of the dip pipe E, Figs. 241 and 242; suppose the dip pipe to be 4in., and the outgo pipe the same, then the 4in. outgo J, Fig. 243, will take up 4 inches of the band, that is from the top down to the soil pipe or outgo, as at K Fig. 262, and also as shown in the section Fig. 244. Then you must have the dip longer than this to get the seal—which should never in any case be less than 1¼in. to 1½in.; here in this case the bottom of the dip is 5½in. down

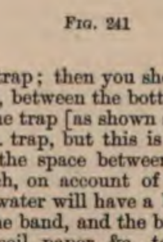


Fig. 241

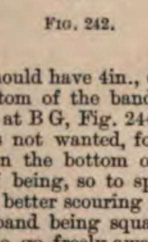


Fig. 242.

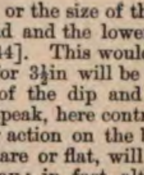


Fig. 243.

the trap; then you should have 4in., or the size of the dip-pipe, between the bottom of the band and the lower edge of the trap [as shown at B G, Fig. 244]. This would be a 9½in. trap, but this is not wanted, for 3½in will be plenty for the space between the bottom of the dip and band, which, on account of being, so to speak, here contracted, the water will have a better scouring action on the bottom of the band, and the band being square or flat, will allow the soil, paper, &c., to go freely away; in fact, although

you have only 3½in. between the band and dip, there is more water-way than through a 4in. pipe. The next part to be considered is the width; this should be, for a self-cleansing trap, only just wide enough to admit the dip, whether 1in. or 6in.; therefore, if you use a 4in. dip-pipe, make the trap only wide enough to admit this pipe.

The Small D-Trap.

I have made traps with 3in. bodies and fixed 4½in. dips inside by working out the sides and heel just sufficient to receive the dip. In this case the trap will pass anything likely to be put into the closet; at the same time it is perfectly easy cleansing, and holds far less water than any other trap made.

Rules for Easy Cleansing Traps.—Firstly: The depth should be twice the diameter of the dip-pipe, in addition to the necessary depth of the seal, which, in a former paragraph, I have said should not be less than 1¼in. to 1½in.

Secondly: The band or width of the trap must be only just wide enough to admit the dip, or narrower, if the cheeks can be knocked outwards.

Thirdly: The outgo soil or waste-pipe must never be less in diameter than the dip-pipe.

Fourthly: That when soldering on the outgo or waste-pipe, the top of this pipe should be brought up to the top of the trap, as at F, Fig. 244, and K, Fig. 262, and be as smooth as possible, and without sharp edges.

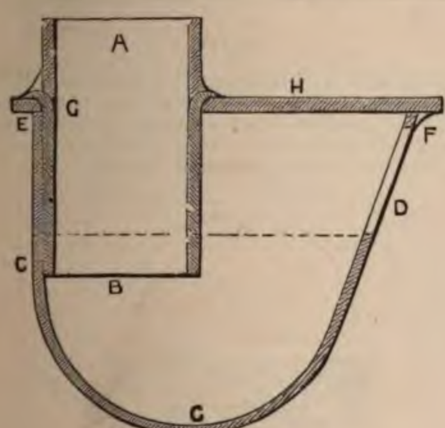


Fig. 244.

Fifthly: Keep the dip-pipe close up to the heel of the trap, as shown at C E, Fig. 244.

Badly-constructed and Ill-proportioned D-Traps

Before I proceed further, I wish to draw your particular attention to badly-constructed or ill-proportioned D-traps. Fig. 245 shows the D-trap not properly made for self-cleansing purposes. You will observe that the dip-pipe is away from the side, and consequently gives room for the fur to collect. The bottom of the dip at F is also furred over; the principal cause of this is the urine. Even with the best-made traps this is likely to take place. I have an S-trap quite full of this matter; but when plenty of water can be used, and the trap properly constructed, this formation of fur is entirely prevented, whether it be made for preventing siphonage or otherwise.

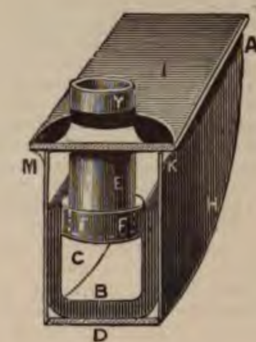


Fig. 245.

Fixing the Dip.

The dip is best in two pieces, as at E G A, Fig. 244. The inside, or, properly speaking, the dip, should be turned or flanged back (sometimes called "tafted over," a word used in London, but I do not know the reason) so as to rest on the top and receive the inlet part of the dip. This should be made for ordinary closets with 4½in. soil pipe, excepting you have your closet to hand. Then measure the trunk or outlet and put your dip in to fit accordingly.

The dip, if cut in large quantities should be cut in the square cut of the plumber's mitre block, Fig. 161, to ensure the same being true, which is very important for the bottom part of the dip, and must not be overlooked. You cannot fix this dip quickly and properly without the turnpin. Sometimes, however, this dip is put in one piece, but don't fix it after the top is soldered on, as it is more work. Solder the dip and top first. The general plan practised is to solder the dip from the outside of the top, but it is much better soldered on the inside of the top, inasmuch as you can have the boards cut down square to the dip where the trap is fixed. It is also better when the safe has to be soldered, because you do not have the dip pipe solder to contend against. In fact, there is no reason why all D-traps cannot be always made in this way. I have described the planning and cutting of good, reliable, self-cleansing D-traps; the following is a description of making them up:—

Fig. 246.

Having cut out the cheeks and band to the proper size, take the dresser and flatten the lead quite smooth; then plane the bands parallel and square to the heel. Rasp the rounded edges true one to the other, to have them the same size and square to each other; here a small hand-vice will be found very handy to hold the cheeks together while

rasping; next place them side by side, and soil them all over the inside and on the outside, as illustrated at H N P D, Fig. 246. The soiling at H should be $2\frac{1}{2}$in. wide, and at D from $\frac{3}{8}$in. to $\frac{1}{2}$in. wide, with the angles N P cut rounded. Next take a gauge hook (some plumbers here use an ordinary shave hook, and for straight work a straight edge, but this is not so good as working with a properly constructed gauge hook) and shave round the *inside* one inch from M to D and from D to J, touch the shaving over and do the other cheek. Now take the band, Fig. 247. which is the exact length, round the cheek, or it may be a little longer, and the width of the dip-pipe, which for a 4in. dip, will, as a matter of course, be 4 inches *plus* the thickness of the material. Plane up both edges, as at A E B F, to the desired width, and parallel, and cut the heel part I square to A B.

Sometimes when fancy work is wanted, the edges of the lead are rasped off to form a mitre, but it is labour thrown away. Let the bottom edge of the cheek be well cleaned and the joint will be perfect. Soil over all the inside, then the outside, as marked out, then take the gauge and shave the inside of the band to the same width as you did the inside of the cheek, but on both sides. You now want a "trap-block," which is a piece of 3in. deal, say 18in. long by 11in. wide, planed up smooth. It must, moreover, have something to keep it from warping. A good plan is to put two pieces of iron barrel through the centre of the stuff,

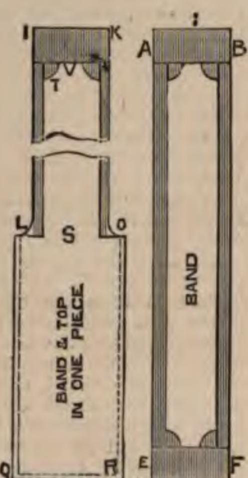


FIG. 247.

and near to each end. Next lay the cheek inside uppermost upon this block, and, with two small clout nails, fix it there by driving the nails through just where the shaving will come when soldering on the top, as at the dots near H, Fig. 246, and as at A A, Fig. 248. Take the prepared band and place the end (which, of course, should be square to the sides) to the heel of the cheek at M, and with a 2in wrought-iron clasp or clout nail just driven nearly upright into the block, say $\frac{1}{4}$in., to hold it in position; that is to say, the edge of the band up to the heel of the cheek. Now bend the band truly up round to the edge of the cheek, and fix it there by driving a few more nails into the block, as at B, Fig. 248.

Next place a piece of board across the top of the band and a small weight to keep it there, and then solder up the trap, which is done as follows:—

Having everything in readiness, with splash stick, cloth, and chipping knife, and a light if you cannot see, which is often the case in some shops. First splash on the solder carefully round the joint, as at D F E, Fig. 248, and when the heat is nicely got up (if required here use an iron, but you will soon learn to do this work without an iron, briskly work the nose into the solder from E to F and D turning the iron round and round so as to plough the metal into a semi-liquid state); then take a branch cloth, say, $2\frac{1}{2}$in. by 2in. and wipe from right to left or from left to right, as you think proper, but whichever way, do it at one quick sweep. If you wipe from F to D, when you get off at D, take a chipping knife and cut the solder square off before it sets; do likewise at E.

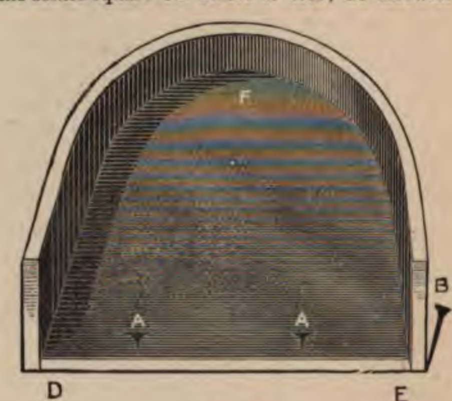


FIG. 248.

Some plumbers wipe from about the centre or bottom of the cheek, and do it at twice. So may you; but the former is the quicker, and, as quickness is the principal part in wiping, it must be the best. Having one cheek soldered on, do the other in a similar manner, by first preparing and

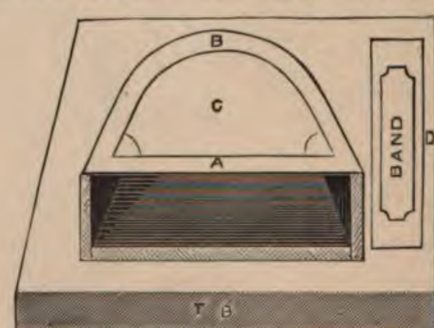


FIG. 249.

fixing the body as shown at Fig. 249. Be careful that the heel of the trap is square with the band, and quite true or level; next, shave all round the outside of the top or body at A, Fig. 249, or L H, Fig. 236, and bore a $\frac{1}{8}$in. hole as an air-hole, at just about J, Fig. 236, or, as at F, Fig. 233, or where the outgo will be; this is to allow the air to get into the trap when it is cooling down after soldering up. This small hole is important, or the sides would be pressed in with the extra pressure of the atmosphere, owing to the interior air condensing as it cools. Now, having the body of the trap all ready for soldering to the top, prepare the top as follows: Take a piece of lead well flattened out, soil over the inside part and edges, also about three-quarters of an inch round the under-side of

the edges, which, when soldered on the body, will be the top side. This prevents the solder uniting to this part of the lead while being soldered on. Place the body of the trap on the top, taking care that it is properly fitted, and, with the compasses, scribe all round the top. Then remove the body, and shave the top 1¼in. wide, using an iron straight edge for guiding the shave-hook, and it is ready for soldering on. First look after the air-hole, then place the top on the block as shown at Fig. 250; which

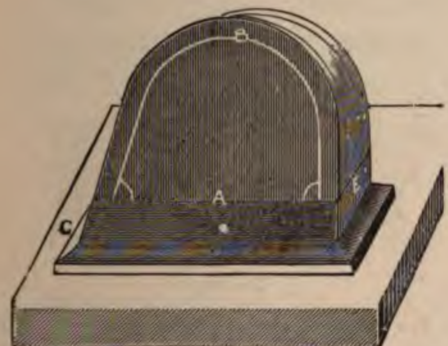


Fig. 250.

is all the better for being warmed; now splash on the solder; first begin to splash it on slowly, then by increasing the speed and quantity until all is in a good semi-fluid state. Be *quick* and wait for nothing, nor think of anything but your work, trying how quickly you can do it and in as few movements as possible. If you are quick you can splash on all round, and get up a good heat and wipe without an iron; but if you cannot do all at once, splash all round and warm up with the iron, and wipe off from right to left, commencing at the outgo corner. If you cannot manage to wipe it quickly enough this way, splash half at a time and wipe, but leave sufficient solder unwiped to begin again with when resplashing, and keep this point in a fluid state; then warm up again with the iron, and finish, taking care to well warm up the solder where you commenced to wipe, so that it will not look rough at this point. Having wiped all round, trim the spare lead off the top, which would be all the better if you have an inch or so; but at any rate, trim it off square and true, or plane it off.

Next is the dip pipe. For this again refer to Figs. 241, 242, and A B, Fig. 244. When soldering it on after the top is soldered on, it is necessary to paste some brown paper over the solder below, to keep it from falling off as follows:—

First procure some good stout brown paper, cut wide enough to go over the soldered flange and on the cheek and top, say ½in., then soak it in water until it is soft (to hurry its softening work it between the fingers); now with some good paste [see Plumbers' Paste], put on by spreading it with the forefinger, paste the paper and place it on the solder in such a manner that it cannot, when in a melted state, fall away from the lead.

Wiping in the Dip.

First splash on the metal until you can feel it all nice and soft, then take a clean sweeping wipe with the left hand; take the cloth in the right hand, and from the starting point take another clean sweep and finish off at the side, or where you left off with the left hand.

Putting the Dip in D-Trap before Soldering on the Top.

This method of soldering on the dip first is far the best plan, if you have a proper trap-block for the purpose, which is nothing more than having a hole cut in it to allow the dip-pipe to drop through; and if you arrange it properly for one trap, you can make the block the correct height for gauging the right depth of the dip, that is to say, for 9in. traps, the top of the block should be 5½in. high—here you may put in the dip-pipe in one piece, or, if you like, you can solder on the dip-pipe from the underside of your top, which will allow the boards to go down with equal thickness over joists, but the evil attached to it is that this solder comes in the way when soldering on the top, and does not look so well.

D Hunch-Trap.

This trap is made to answer the purpose of the ∽ hunch-trap, Fig. 216, &c., in positions where the pipe is required to be continued in a straight line. For mode of construction, commence by cutting the cheeks and outlet in one piece;

Fig. 251.

then solder on the back band G D M, next solder the inner band F A I E to form the outlet lip F, after which the small back piece A H; you must then put the top on as in an ordinary D-trap. This trap is also well adapted for use in cases where the closet or urinal, &c., is situated in a recess in the wall.

The ᗡ-Trap, or Foot-Trap.

This trap [Fig. 252] which exactly resembles the letter ᗡ, is in principle the same as the ᗜ. It is known in some districts as the "foot trap," for fixing at the bottom of soil and rain-water pipes when connecting with drains. It is

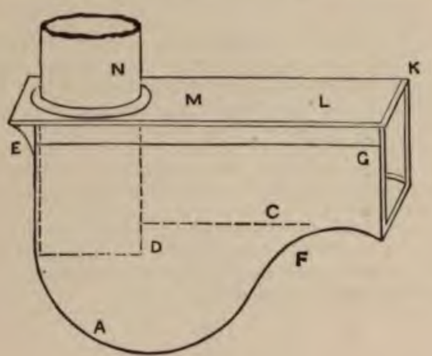


FIG. 252.

astonishing to find to what an enormous size some of these traps were formerly made. I took one out of a servants' hopper, at No. 16, Addison Road, Kensington, which weighed 136 lbs., whilst at other times these old traps are to be found of not more than 9in., weighing not more than 15 or 18 lbs.

The proper method of striking this trap correct is as follows :—To make a 9in. trap, open the compasses 4½in., and describe the circle A, Fig. 253 ; draw the top line E B, cutting the circle as shown. Now draw the water line C F, which is generally the size of the dip-pipe ; that is,

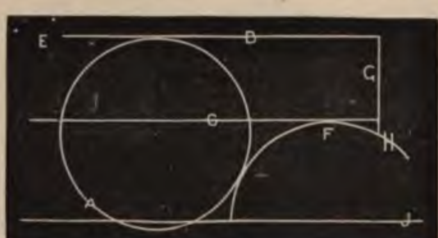


FIG. 253.

assuming the dip-pipe to be 4in., you should keep the water line 4in. from the top, though, if necessary to get a little more dip, you may make it a little higher. Next, with the same radius (4½in.) strike the arc H F, cutting the water-line, and also the outside of the first circle, as shown, then strike the heel line E square with the top-line, and cutting the circle, also strike the outlet end H G. If you prefer a sharper outline curve, set the compasses at a smaller radius. The trap is made up in the same way as the ᗜ-trap, excepting that the solder-line round the top does not join.

ᗡ-Trap with Solid End.

The object of this style of trap is to save a bend on the soil-pipe, and is done by making it with a stop or solid end, and taking the soil-pipe right down as at J Fig. 254. Make the joint F on the botton of the band (which should be straight at this point), wipe round the cheek, as shown at F. Be careful not to have any sharp angles, and that the trap is not wider than the outlet; also that the soil-pipe is fixed in a line with the solid end. On the top of this trap is shown at L a cleansing cap and screw, which

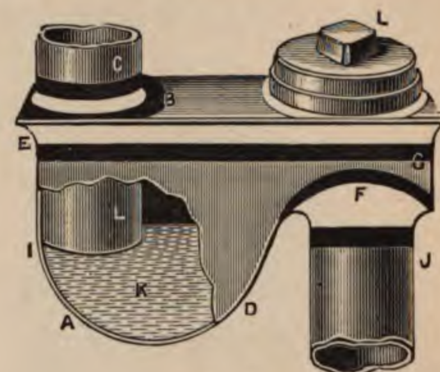


FIG. 254

answer two purposes, namely, to clean out the trap and also the soil pipe. Of course this trap must be, when fixed, properly ventilated, and should the cap and screw not be required, the ventilating pipe may be fixed in a line with the soil-pipe J. Sometimes these traps can be used advantageously over soil-pipes running at the back of the closet in a horizontal direction.

You will notice that in the former illustration [Fig. 204] of the old ᗡ-trap, that the rise to the outlet is much more sudden (as in the old-fashioned ᗜ-traps [see Fig. 230]) than in the above illustrations, which is a good check should these traps be made very small against momentuming out when fixed under valve closets. Of course the pattern of

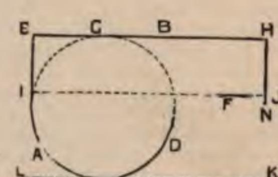


FIG. 255.

these traps may be cut out without the outlet curved line, and by making the outgo straight, as from J F, Fig. 255, when it will be impossible for it to momentum out, and almost impossible to siphon out, because then the curved line D goes a little back towards the inside of the trap at the line F I, which tends to throw the splashes from the air bubbles inwards, or towards the dip.

The Eclipse Trap.

This trap, as will be seen, is a species of the ᗡ-trap cast in one piece ; the outgo, as in the S-trap, Fig. 256, is made with a much too easy curve at the outlet. If the curve-line U, Fig. 256, had been brought nearly direct up from U to the letter R, then this trap would have been one of the best to be found in the market. As it is, it is a good

trap for fixing below hopper, pan, or other such closets, but is not what I should consider good in its present state, viz., it is not suitable for valve closets. I should also like to see more dip given, for those which I have seen are barely $\frac{7}{8}$in., but this cannot be said to be the fault of the inventor, but that of the maker. Fig. 257 is an elevation of the Eclipse trap.

Shallow Traps for 7in. Joists or D-Trap with Flat Dip.

This trap being my own invention, I commence by giving my readers the proper instructions for its manufacture.

Make the body [Fig. 258], M D J I, as you would the body of the D-trap, and then wipe in the inlet-pipe Y. Now measure off from M to the front of the dip, and with a saw cut the cheek down to the depth you require for the water lock; then cut the other side, and finally, across the top. Prepare a piece of stout lead, K, just wide enough to drop into this cut, and burn it there, or, with a copper bit, solder a good thick seam all round the cheeks and top; or, should you prefer to wipe it in, let the plate be prepared so that it will stand out half an inch all round. The plate or dip may be soldered in before the top is wiped on or afterwards.

The object for making this style of trap is to obtain the width for water passage in shallow traps across the dip, which allows anything to pass from the inlet side to the body of the trap.

This trap in reality is a siphon, and should not be made more than 8in. deep and 4in. wide. This trap may be used for such places as between 7in. joists, and may be made the smallest of all traps used in closets, but when used for 7in. joists, the following is the method which I find works best after five years' experience with them upon some property built by a Mr. Hurst at New Barnet. Notice that the cheek in this figure [258] is drawn to my usual pattern for D-traps, which answers for 9in. joists. Measure from the bottom up *seven* inches, and strike a right line, M J, which reduces the height of the trap 2in.; next strike the heel line, M D, square with the top line, and set your compasses from the heel point, M, to the external periphery at the front of the trap as you did in striking the D-trap; with this distance work off the length of the top as at J. Now draw the outgo line, cutting the point at J, and the periphery of the circle; the shape is then complete.

Let the flat dip or tongue, K, be placed $4\frac{1}{2}$in. from the heel at M, and $4\frac{1}{4}$in. down into the trap; this leaves a space of $2\frac{3}{4}$in. at the bottom. The width of the trap should be 5in. Here you have a space round the bottom of $2\frac{3}{4}$in. by 5in., which will allow anything to pass, under ordinary circumstances, from the basin into the trap. The outgo of the trap should be cut down $3\frac{3}{4}$in. right across the front of the trap. This leaves an outlet of $3\frac{1}{4}$in. by 5in., which is plenty large enough for the purpose.

Notice.—Should you wish to convert this style of trap into a V-trap, you may do so by cutting the slot C K B A to a V shape and putting in the piece accordingly.

The Adee Trap.

This is an American trap, the action being that of the D-trap, but made in halves, as shown at A B, Fig. 259. D is the dip pipe, S the soil pipe, C the cover, E the body. While not wishing to say anything derogatory of this trap, I nevertheless think that it has a fault, namely, the outgo pipe coming up to the point F. I think if the band were

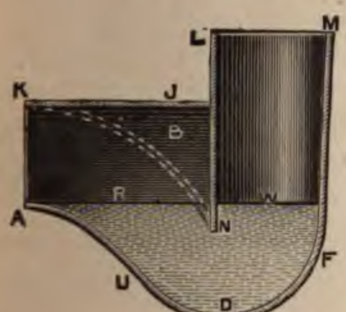


Fig 256.

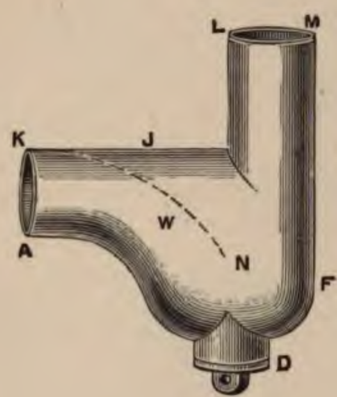


Fig. 257

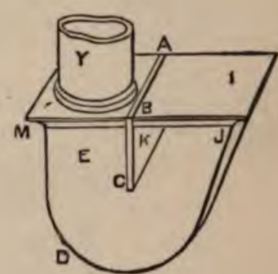


Fig. 258.

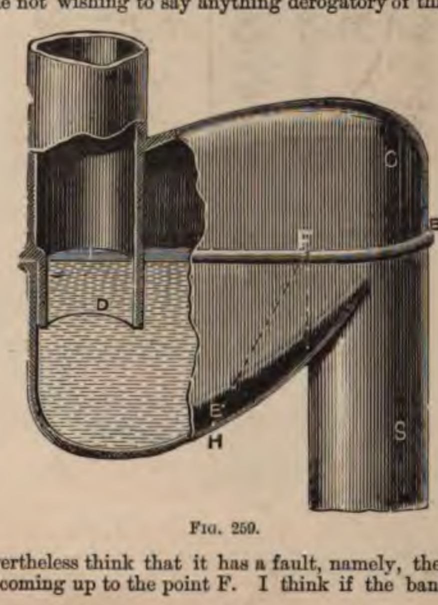


Fig. 259.

taken up as per dotted line E A, the soil would have a much better chance of getting away. Adee claims as one of the great merits of his trap that it will not siphon out, but this is nothing if an air-pipe is used. However, it will not wave out, which is a great advantage.

The Composite Trap.

This trap, Fig. 260, as before observed, is a compound of the ᔕ-and ᑌ-traps. On examination of the figure, at A,

FIG. 261.

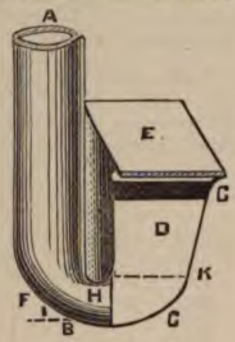


FIG. 260.

F, B, it will be seen that in the inlet and heel part of this trap that it is made with the flat throat at H and K, the outgo part is composed of the portion marked D; this dip K J, Fig. 261, being flat and straight across, as in the three-quarter or cut-down ᑌ-trap, it allows the soil to get away easily without so much of a dive. This trap is easily made in the following manner: First make the body D, after the fashion of the ᑌ-trap, then make the knuckle-bend J K L, but flat at the throat H, Fig. 260 (as also shown at Fig. 198), and solder or burn it to the heel of the body D, as shown at the line H, Fig. 260, or it can be cast in one piece, or by casting the dip and body D in one piece, and then by burning or soldering the top E on afterwards. The *outgo* of this trap, as also the ᑌ-trap, may be on the side or check to suit the work.

Before I proceed with a further description of traps, I will give you a few interesting experiments on siphonic action, momenta of water in traps, &c., after which I shall proceed to describe some of the smaller class of traps in general use.

Experiments with Closet and other Traps for Illustrating Momenta, Waving Out, Siphonage, &c.

When selecting the trap for a water closet it is very important to know what kind of closet is to be employed. For instance, a valve closet should have a trap which is proof against waving or momentuming out, which will be readily understood from the following description and diagrams:

When a full sized valve closet is fixed over a trap, and the valve opened and then suddenly shut, the moment the body of the water is out of the basin, the water is by its own momentum carried forward, which may be accounted for as follows: On lifting the handle W, Fig. 262, it brings up the lever H, with it the tumbler pin G, and the crank which works an axle having the loose valve F attached; the water then runs the full bore of the dip-

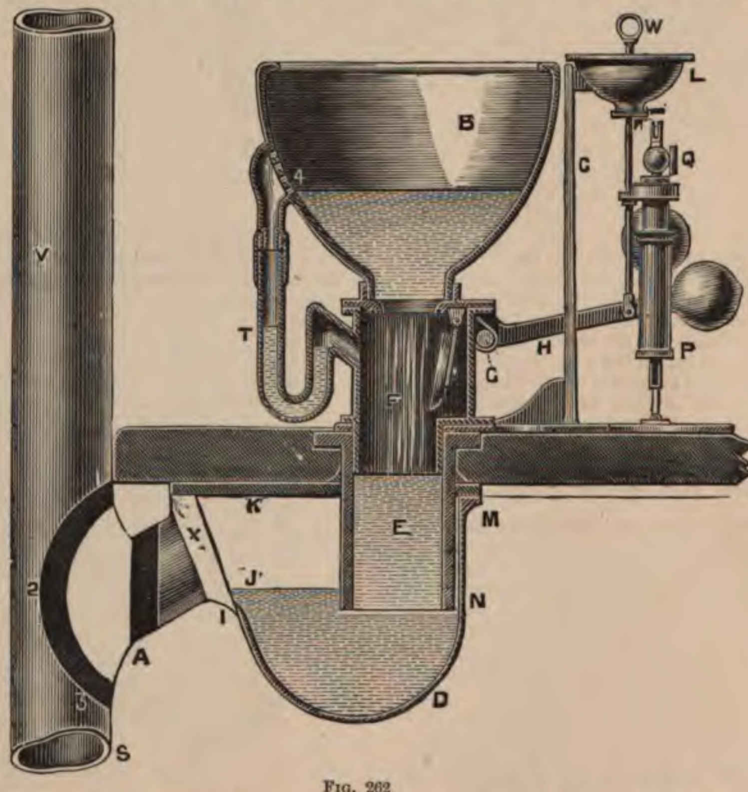


FIG. 262

pipe into the trap, striking against the band at D; otherwise, if not for the band, it would proceed onward as indicated by the lines B S R, Fig. 263; but as the band

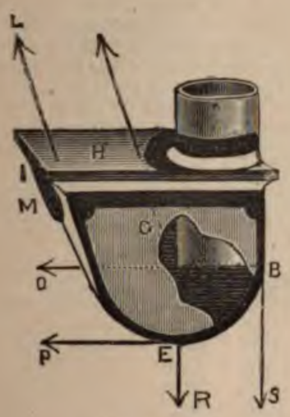


Fig. 263.

is rounded the water is directed towards E P, where it would, if not for the front of the band, pass off in the tangent line, E P, but it is guided onward until it comes to the point of contact with the tangent line L; it then strikes off in a right line, and dashes up against the top, when it is reflected or thrown back against, so to speak, its own life-giving pressure, in what I may call a state of eddy confusion, when it is greatly retarded, and passes out at the outgo M without any sign of loss of water within the trap from momentum, that is, when fixed under slop or valve-closets.

Next refer to Fig. 264; here the half ᔕ-trap of faulty

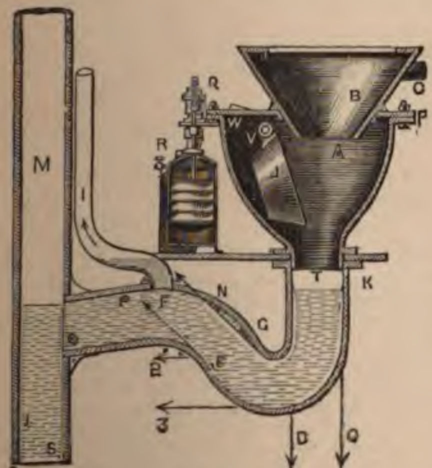


Fig. 264

shape (as spoken of at Fig. 205) is fixed so that you may see one of its evils. Suppose a valve closet as at Fig. 262, or as at Fig. 265, to be fixed over this trap, and the handle pulled as at Fig. 262, the water would rush forward towards D C, Fig. 264, then round the heel of the trap to E

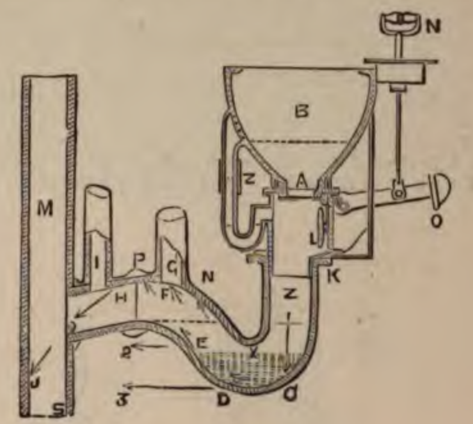


Fig. 265.

and strike up against F, where it, owing to the shape of the trap, will be directed onward and out of the trap, leaving it as shown at E X, Fig. 265.

Bad Places for Air Pipes.

You can easily understand that if you fix an air pipe in the way of the momentum line of the water, that the water will throw up the solid matter, such as paper, &c., and very soon cause the air-pipe to become blocked up, and consequently useless. Examine I, in the above figure, also F, Fig. 264. I, Fig. 265, in this last drawing, is the proper position for the air-pipe, as close to the round joint of the outgo as possible, so as to be out of the way of the momentum, &c., but, of course, it is not required unless the length of outgo pipe is longer than shown in the figure.

Slop-throwing through W.C.'s, &c.

Scores of times I have been called out to examine servants' slop and other closets, and have been puzzled to find out the cause of the periodical stinks, in consequence of the trap becoming re-sealed before I have had time to get to the house, and on examining the traps for air-pipes, thinking it may be siphonage, I found them all right. The reason, however, is now quite plain. Let a pail of water be thrown down the W.C. pan-closet, Fig. 264, and the handle shut down before the trap is recharged, and you will find the stink must rise. How often is this done when there is no water laid on, or during the time there is no water in the cistern? and again, how often in the winter time are we obliged to flush out the closet during the time the pipes are frozen—better known as hand-flushing? All these points have to be considered before fixing the trap.

I may here remark that I never fix the old pan closet, as shown at Fig. 264, but when such have to be fixed you will do well to examine Banner's improved kind of pan closet, made in earthenware, and which can be readily cleansed. I have, by the foregoing examples, shown you sufficient to put you in a position to see the effect of momentum on

easy going outlets to traps, as illustrated in Figs. 264, 265, &c., but in order that you may clearly see what is meant by this very important subject, allow me to remind you of one of the first laws of motion. We are taught to distinguish the meaning of the word "inertia," which is the simple resistance of matter to a change of state, whether of motion or of rest. Let us, for the purpose of this argument, examine Fig. 266.

In the bottom of the trap there shown will be seen the water, K D C, apparently stationary or in a state of inactivity. In the same diagram will also be noticed the water dribbling from the valve F. This dribble is not enough to engender sufficient momenta to instantly throw out the whole of the water within the trap; therefore, the

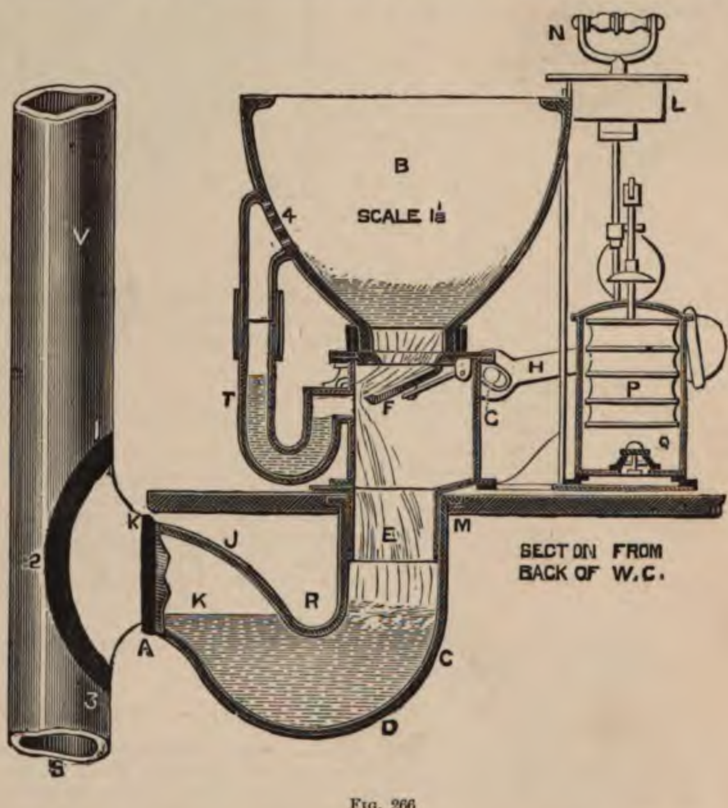


Fig. 266

inertia of this water cannot be said to be acted upon, as it should be, by the incoming water from the valve F, and whenever this constraint occurs, there is a resistance brought into play which is known in mechanics as reaction, and which in this case is totally fatal to all self-cleansing traps. In this illustration and explanation you have a clear proof that the handle of the closet should be moderately quick and fully pulled up, in order to enable all the water to pass full bore and rapidly into the trap, so that the incident motion directed from the water in the basin shall have full power to expel the whole of the foul water contained within the trap. This applies to all traps—closet or otherwise.

The above trap represents Beard and Dent's 4in. Cast-lead Trap, which I have proved to be a failure for slop or valve-closets.

Thousands have been fixed yearly, and cause no end of trouble; of course, there are places where such traps can be used with safety, but on no account can they be used below a valve closet, nor below any kind of closet having a quick emptying valve similar to that shown at 15, Fig. 267, which, although not known as a valve closet, nevertheless is one, and if you pull the handle, thereby lifting the valve of the closet, the water, like all other substances, will obey the definite law of gravitation—it will fall, with accelerated force, onward towards R S; but as the bottom of the trap is rounded, the water is easily turned out of its straight line of path, from B to C D E, and at each successive instant will tend to fly off in due proportion to the speed. If the front, from E to F were cut away, it would fly off at the tangent, E P F O; but, as the front of the trap impounds this water, it is again directed from the point of contact, H G, towards the tangent line, L U, when it again glides round the too easy, curved line G J U, and flies off at the tangent, L M, as though it were a stone from a boy's sling.

Now the effect of this is, that with a closet-basin half full of water, having a valve fixed only 6-in. from the water-line in the trap, on the valve being properly opened, so as to cleanse the trap, the water will gain sufficient velocity to sweep onward; and as there is not sufficient reaction, neither by friction nor by the curved lines of this particular trap, the momentum of the water is unchecked, and consequently the trap left without sufficient water to prevent the air passage, as shown at X, Fig. 265. Now suppose this to be a pail of slops, it will have the same effect.

This result is palpable if you only consider the weight of the water and the curves of the trap, which may be compared to a bagatelle ball passing round the head of the table.

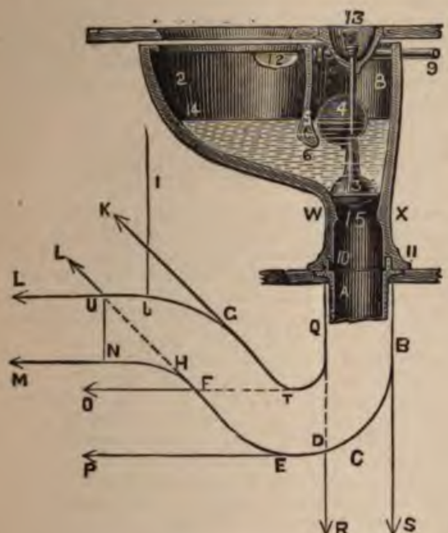


FIG. 267.

Now let us examine Fig. 268.

This is the eclipse trap, to which I would have trusted my life, until I discovered the momentum of water in traps, when at the Trap-Testing Congress, held at Messrs. J. Pullen and Son's establishment, on October 18, 1881. We are told, and it is a fact, that water will always pass onward in a straight line unless it meets with some substance to check it or divert its course. Now, suppose this trap to be fixed

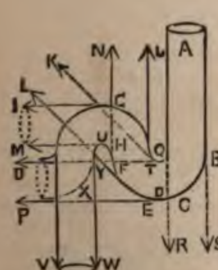


FIG. 269.

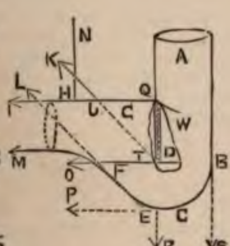


FIG. 268.

as shown at M, Fig. 271, having the basin C on top; three-parts fill the basin and lift the full-sized valve as shown at F 7, Fig. 272, as you would were it a valve-closet, and thus fill the pipe part 4, 4, 3. The water on falling will strike against the bottom B C, Fig. 268, and would fly off at the tangent-line O P, but as in the ∽-trap before referred to, it is by the very easy curve, E F, directed in the line F L T K, up against the *rounded* top, H, when it is re-directed to the outgo. This, I think, is quite clear, and will be readily understood on reference to the dotted lines, shown in my diagram between K and N, Fig. 257.

Now you have seen the effect of water passing through the eclipse trap, next let us examine the ∽-trap as illustrated in Fig. 269. This is the complete 4-in. ∽-trap, but owing to its shape it is extremely unsuitable for general work, to say nothing about its being difficult to make. For instance, from outside to outside, or S to V, is 16in.; then again it is at least 10in-deep—that is from the top at G to the bottom at E. Lately it has undergone a slight alteration by the hands of Mr. Daniel Emptage, of Margate, who has curved the outgo to D P X, Fig. 269. I may here remark that these traps are excellently made to almost every conceivable shape by the patented process of Frederick Nelson Du Bois [see Fig. 193], and sold by Mr. G. Jennings.

This trap, owing to the top part being suddenly turned back as at G, Fig. 269, reflects the water back somewhat as in the Ʊ-trap, and so prevents momentuming or waving out [also see the anti- Ʊ-trap at F, Figs. 227 and 228, also Fig. 278 at L *a c*.]

Trap-Testing.

At Messrs. J. Pullen & Son's establishment in October, 1881, there was erected a scaffold about 45-ft. in height with soil pipes leading from top to bottom; upon these soil pipes were fitted branches with slip-joints for receiving any kind of trap suitable for fixing below a closet, such branches being placed every 8 or 10-ft. up the soil pipe for the especial purpose of experiments. It was my good fortune when attending to test the various traps, to have met with some of the best plumbers now in business, as also members of the National Health Society, and it affords me great pleasure to have the opportunity of informing my readers of the various effects of the experiments on the different traps.

"Some of the self-yclept" "Sanitary Engineers" and "Practical Plumbers" will be astonished at the result of these soundly practical experiments.

A, Fig. 270, represents a full-sized Sharp's pattern basin, 14½in. wide and 12in. deep, fixed from the top rim of the basin to the top of Ʊ-trap, 17in. high, and over a full-sized Pullen's cast-lead Ʊ-trap: the height of the soil-pipe from the basin A to the foot of the pipe is 45-ft. The bottom of the basin was plugged, the basin then filled with water, and in spite of all efforts, and however much water was applied, when the plug was suddenly removed, the trap could not be emptied of water nor the water-seal destroyed, even when the cap G was made air-tight over the top of the soil pipe. The reason why it cannot be siphoned out is palpable, for on reflection and by reference to Fig. 280, it is clear that in Ʊ-traps made full size to prevent siphonage, that you can only siphon the water out which is contained within the dip part of the trap. On the opposite side was afterwards fixed an ∽-trap, and although we endeavoured to unseal this trap by siphonage from the Ʊ-trap, it was found *impossible*, although the cap G was quite airtight (the reason was simply because the dip or water-seal in the ∽-trap was 2½in. against 1-in. in the Ʊ-trap), therefore the necessary air rather went through the Ʊ-trap without affecting its water-seal. I should state that if the dip in the Ʊ be too much, the ∽-trap will siphon out. Mr. Buchan tried this experiment with another Ʊ-trap, and then the ∽ siphoned out, which proves that a shallow dip must be given to the Ʊ, if it is to supply air to prevent siphonage in the ∽-trap.

For the next experiment some 2½in. square stones were placed inside the D-trap, three of which were washed away by one basin of water. Then one teaspoonful of ink was placed in the trap, which required two basinfuls of water to thoroughly cleanse it. Then we placed a handful of closet paper into the dip part of the trap, which was washed away by one and a half basin of water.

FIG. 270.

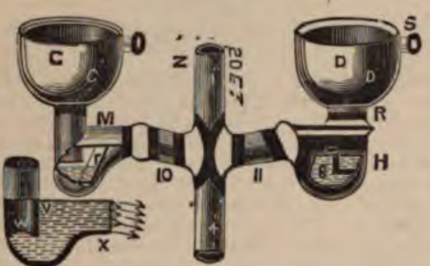


FIG. 271.

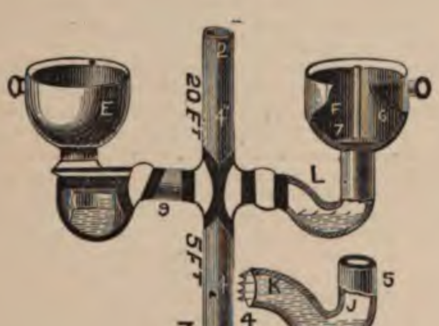


FIG. 272.

A house-flannel 2-ft. 6-in. by 2-ft. was put into the dip of the D-trap, and was thoroughly washed away with three parts of a basin of water, so that the action of the D-trap can be certified as follows:—

That it cannot be siphoned out; no momentum of water would destroy the water-seal; a full-sized house-flannel will pass through it with three parts of a basin of water; three stones, 2½in. square, will pass out by the impetus given by one basin of water, and, it cannot ebb or wave out.

The Helmet Trap.

[Fig. 271.]

[Also see Fig. 235]. This trap has a rounded bottom, and holds considerably less water than Pullen's large D-trap, or the above-mentioned.

It was filled with water, and on raising the plug in the bottom of the basin D, it was found impossible by momentum to destroy the water-seal, nor could this full-sized trap be siphoned out.

Small-Sized Helmet Trap.

When the trap was made to my lines, viz., with the band only just wide enough to admit the dip, then it could not be made to momentum out, but could be siphoned out from its own basin, and only then when the cap G and other openings were closed, or when we raised or lengthened the outgo to a fall of 6-in. in its length, which siphonage was prevented by the use of a ½in. air-pipe.

Four pieces of brick and stone 2½in. square, were all carried before the water down the soil-pipe.

The house-flannel, 2-ft. 6in. by 2ft., as also an extra piece of rag 3ft. by 13in., were completely cleared by half a basin of water; then one teaspoonful of ink was washed completely away by one and a half basin of water. A handful of closet paper put into the dip was cleared out with one basin of water,—the inference necessarily being that the helmet trap is self-cleansing; it can be unsealed by siphonage; it will not momentum out, and it cannot ebb or wave out.

The Small D-Trap.

The improved pattern D-trap with band narrower than the dip pipe.

This trap was tried with the following results: It was half filled with stones, from 2in. to 2½in. in diameter, the whole of which were flushed out with one basin of water; then the before mentioned flannels were put in, which were sent out with a quarter basin of water; a handful of paper was sent out with a quarter of a basin of water. The flannel and paper together were entirely cleared with the water running from a cock at the rate of 4 gallons per half minute. Two teaspoonfuls of ink were entirely cleared away with one basin of water. It was impossible to momentum it out. It was siphoned out when placed at top of the pipe and all other apertures being closed, by discharging one basinful of water, a half basinful not being sufficient.

Beard and Dent's ∽-Trap,

Fig. 270, on the right, is a closet basin exactly the shape and size of A; the trap was first filled with water, the basin plugged, the cap G taken off the top of the soil pipe, and the basin filled with water; then the plug was raised, and in an instant the water rushing from the basin cleared nearly the whole of the water from the trap, leaving a gap of at least ¾in. below the throat of the trap, thereby at once leaving the trap totally devoid of water-seal.

Now this action, as described above, is very easily explained, and is that, owing to the shape of the trap and its having so smooth a surface, it cannot resist the impetus of the water from the basin when the plug is raised; this is illustrated at J K, Fig. 272, also at B E F, Figs. 275, 276, and also at Figs. 264 and 265, by which it may be seen that the momentum of the water is carried forward, and to a

considerable depth below the throat of the trap, at times even as much as 3in.; but as soon as the water breaks or parts upon the top at K, Fig. 272, or better shown at E, Figs. 275 and 276, the hinder part of the water falls back into the trap, but in not nearly sufficient quantity to refill the trap, and so re-establish the water seal. [See X., Fig. 265]. It should be remembered that water, like a ball, will proceed, unless checked by another quantity (in one shape or other) having equal weight and power, but this not existing in the ɷ-trap, renders it useless for valve closets, slop-closets, or for any kind of closet which may be hand-flushed, that is, by throwing water from pails, &c., proving at once that the ɷ-trap is unsafe for valve closets or any other closets where large quantities of water have to be thrown down at one time, and is especially unsafe for housemaids' sinks.

The trap was then tried with the cap G replaced on top of the soil-pipe, and the action was precisely the same, and we could not get any more out than before. The trap L siphoned out when the top right-hand basin was discharged. The top right-hand basin trap will siphon out when a basinful of water is discharged down the top of the soil-pipe and the basin A plugged.

This proves beyond question that the full size D-trap will not only supply air enough for its own proper working, but enough for other traps that have a greater water-seal, if fixed upon the same level. It can afford to help others without interfering with its own efficacy. The additional tests of the ɷ-trap were, that on placing five stones 2½in. square in the trap, they were washed right away by one basin of water. The house-flannel was washed out with water running full bore from a ¾in. cock (rate 4 gallons per minute) and was also washed out with a quarter of a basin of water. The teaspoonful of ink was cleared quite away with one basinful of water.

The Eclipse Trap.

This trap is shown at M, Fig. 271. The basin being filled with water, and, as in the other tests, the plug suddenly raised, the water rushed through and left the water seal broken ½in. below the dip, although plenty of air was given through the soil-pipe. This was an undeniable proof that the fault of the trap consisted in momentum of the water, and not in siphonage, showing that it has the same fault as Beard and Dent's ɷ-trap, and therefore should not be used for valve, slop or hand-flushed closets. When tested with the stones, one basin of water cleared away four stones 2½in. square. One teaspoonful of ink required two basins to clear it thoroughly away. This trap will siphon out by discharging the top basin, and having the top of the soil-pipe made air-tight, and having the other traps also made air-tight, but not nearly so readily as a Beard and Dent's ɷ-trap. When the flannel test was applied, a quarter of a basin of water was found to wash the flannel right away.

The above tests were also done with one of Mr. Bolding's full-sized best make simplex valve closets, with full way valve at the bottom, the latter of which is not often to be found even in best make of closets. I mention this, as it is a very important point in judging a valve closet; however, you can always have them of the above firm.

I trust these experiments will be sufficient to prove my assertions, that the full-sized D-trap is the only reliable trap against *siphonage*, where ventilation *cannot* be obtained, and that I have now shown you sufficient to enable you to select a trap which will not momentum out; nor, when made as directed, even siphon out when fixed below a valve closet or sink where large quantities of water have to be thrown down at once, and that the ɷ-trap is quite unreliable for these same purposes.

I should inform my readers that, however much I have written on full-sized D-traps, it should be distinctly understood that on no account should this trap be employed unless it is *thoroughly* flushed with water similarly to that shown at Fig. 282, so as to cleanse itself each time that it is used, and in such a manner that it cannot get *fouled* or clogged up with soil and such like; for it is from this very cause, and I may say from this cause only, that the trap has been damned by people who have seen them furred. Of course I do not notice anything that may be said by prejudiced people against this trap, simply because it may be found corroded or eaten in holes, for this is no fault of the trap, but that of the materials, and all traps made with the metals in common use are just as likely to become corroded, no matter whether the shape be D, V, ɷ, or ᴛ, and if people who may find such traps in use, were to simply clean them out and then properly supply them with water, they would only then be doing their duty to their client, and often the trap would be much better than the one they would fix.

The effect produced by siphonic action in traps is well illustrated at Fig. 273. Here, at A, the inlet of the trap is seen to be filled with water, whilst at the outlet side it may, by the waved line, E, F, G, be seen to be only just on the start, it not having yet received sufficient force to overcome its inertia, which is, to a certain extent, due to the resistance caused by the bend of the trap, though a very easy one.

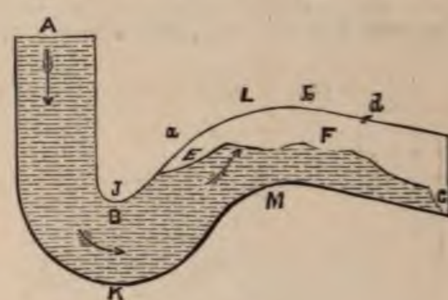


FIG. 273.

Let us now assume that the water has acquired sufficient velocity to carry it forward, and that all parts of the trap and outlet pipe are full, as at B E F G, Fig. 274, and that this motion cannot be suddenly stopped, but that the supply

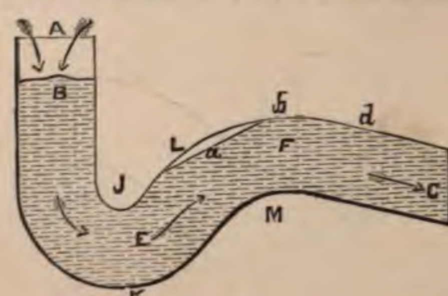


FIG. 274

is suddenly shut off, as shown at B; the consequence will be that a solid plug of water will be forced within the soil-pipe, and its weight will force the air in the pipe before it

when, as this water being in the shape of a plug, and as shown at B, Fig. 274, the air above it instantly rushes forward with an equal velocity to the rate at which the water is moving, and the effect of this air pressing upon the top of the water is known as suction, from the peculiar noise it makes. This air continues to flow up the water as indicated

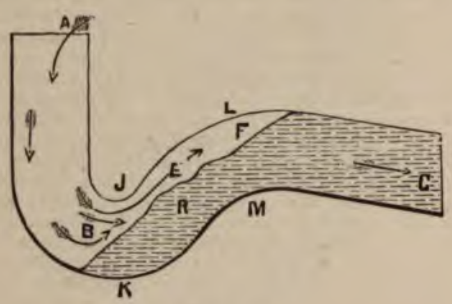


FIG. 275

by the arrows in Fig. 275, and will tend to force all the water out of the trap until equilibrium is established in all parts of the pipe or trap, hence the reason for fixing an air pipe as shown at N, or at I, Fig. 264. Suppose that air is admitted both ways, viz., from F to A, Fig. 276,

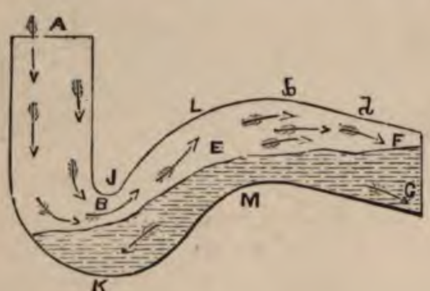


FIG. 276

then the water, in consequence of its non-cohesive properties, will part or divide, because its gravity has overcome its momentum and power of attraction, and obeys the

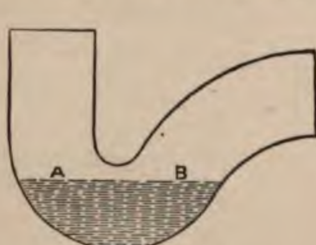


FIG. 277.

superior law of gravitation, as shown at B E, Fig. 276, where it is seen falling back finally to a state of rest, as shown at A, B, Fig. 277. Here is one of the worst evils known in the syphon or round pipe closet traps; the quantity of water falling back after this siphonage is not sufficient to fill the lower part of the trap (see line A B, Fig. 277) and up to the diaphragm, thus rendering the trap useless. A little consideration will show that all this, as far as regards siphonage may generally be rectified very easily by adopting air pipes on the outlet sides of the trap, and as far as momentum goes, this may also be stopped by the use of a proper shape of trap: such a one as is illustrated at A K M, Fig. 278.

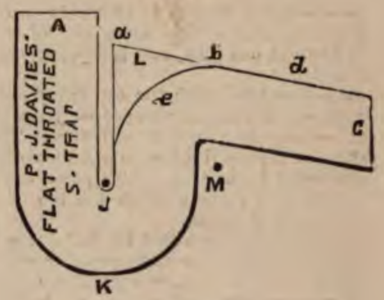


FIG. 278.

Now let us examine Fig. 262, for the illustration of the action of the water when passing through non-siphonic ∪-traps. Here is a valve closet fixed over a full-sized ∪-trap, viz., 13in. long, 6½in. wide at the band, and 9in. deep. On the handle of the closet being pulled up, the water quickly fills up the trap, and fills up the soil pipe, which soon causes it to act as a siphon, and causes the water within the trap to resemble that shown at Fig. 279, where the water in the trap is put into very rapid motion,

FIG. 279.

by reason of the water in a long length of soil pipe running out, and whose weight, if there be no inlet for the air, tends to create a partial vacuum in the top part and also in the trap, but by reason of the atmospheric pressure pressing on the surface of the water in the dip O, the vacuum cannot be produced, the air enters and puts the water within the trap into rapid motion, and when examined through a glass-sided trap appears exactly as that described in Fig. 279. The reason why these ∪-traps cannot be siphoned out is simply this—and which is well depicted in the following figure 280, or in an ordinary glass oil flask,

&c.—A, resembles the dip-pipe of the trap, and H the outlet, but for convenience sake let us use the cork of the flask for the outgo. Now, fill up the bottle with water

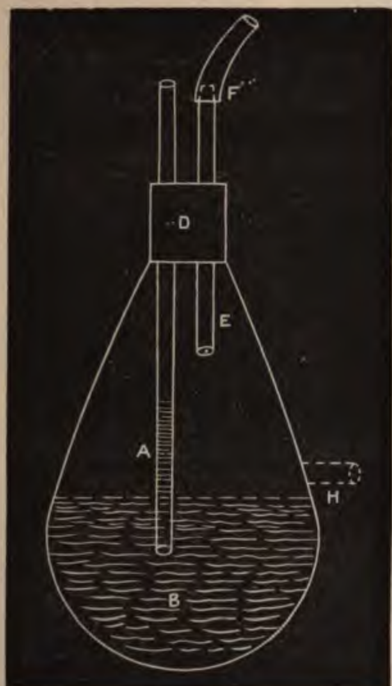


FIG. 280.

as shown by the dotted lines. Then, with your mouth suck away at the tube F (this answers the purpose of the water going down the soil pipe), and you will find that you cannot empty the bottle, not even of one drop. Why? Simply because the dip-pipe A allows the air to enter and pass into the water, it then rises and passes off into the outgo H or E.

The above two simple experiments should be quite sufficient to show that this class of trap when proportionately made is most reliable, so far as regards siphonage, which siphonage can always be stopped (expense and convenience allowing) by proper ventilation, and which every W.C. should have.

Anti-ω Trap.

Now let us examine Fig. 281; A is the dip pipe, exactly as in the ordinary D trap, B the body of the trap, and bottom of the dip, and F G the outlet. The same letters also apply to Figs. 282, 283, and 284. Fig. 281 illustrates, by the dotted lines, the water at rest, and level with the outlet F. Fig. 282 illustrates the water when the trap is being put under a severe test for siphonic action.

The water enters at A, then rushes down into the bottom of the trap at B, thereby striking out any sedimentary matter; and, as may be seen, the water fills up the body of the trap, then flows out at the outlet pipe I K L, filling it up full bore, by reason of the atmospheric pressure in addition to the weight of the water. It now tends to suck everything that may be floating on its surface, or otherwise, towards the mouth of and down the outlet pipe, thus thoroughly scouring and rinsing every part.

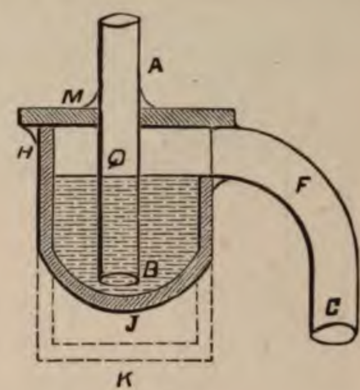


FIG. 281.

But suppose the water to be entirely run out from the basin or other receptacle leading into the dip A, and that air is admitted through the dip-pipe A Q, Fig. 283, and blows upon the surface of the water in the dip, which is instantly emptied; the air continues to force the water away from the bottom of the dip-pipe as shown at B, and bubbles in an upward direction towards the mouth of the outlet.

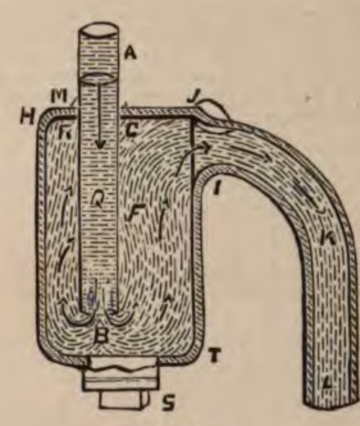


FIG. 282.

The water, notwithstanding its agitated condition, appears to cling to the outer sides of the trap, and when sufficient air is admitted to allow the outlet pipe to empty itself, the water, marked by the uneven or waved line within the trap, and round about the dip, will fall back to its normal state, as shown by the water-line D, in Fig. 284, and notice that this will fall back, and in sufficient quantity to well seal the end of the dip-pipe. Such traps can be made to withstand any ordinary test which may be applied for siphonage, and to answer every purpose; but care must be taken to make the body large enough in proportion to the length and size of the outlet pipe, and that the dip does

not exceed the size of this outlet pipe. I have two at work in my house below some lavatory basins. The length of down pipe in one is about 18ft.; in the other, about 5ft. On pulling out the 1in. plug, the 18ft. pipe basin quickly empties, and leaves $2\frac{1}{2}$in. water-lock out of $4\frac{1}{2}$in., thereby

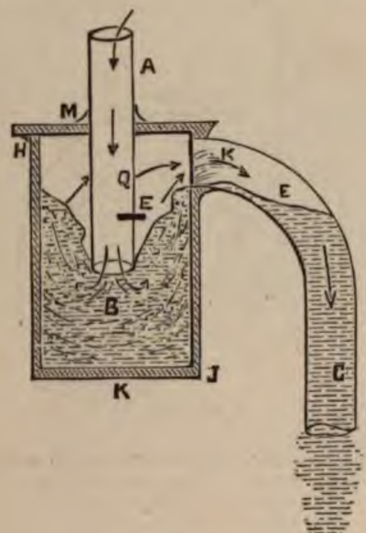


FIG. 283.

only losing 2in. each time the basin is used, and always leaving a thorough good water-seal for protection. Upon close examination I find that it is only the water within the dip-pipe, together with a few splashings, as shown at K, Fig. 283, that disappear from the trap, and that as soon as this is gone, the air is freely admitted through the

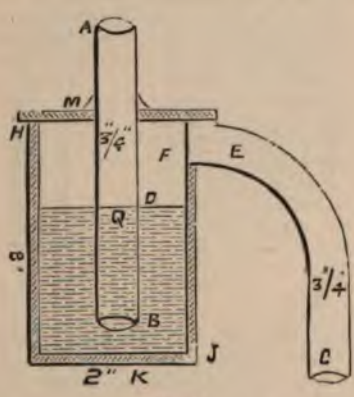


FIG. 284.

water. The traps I speak of keep themselves thoroughly clean, and, in fact, they are all that can be desired. Now, if you examine a ᑌ-trap, you will easily perceive the same action to take place, but take care to have the trap large enough, if *used for the purpose of preventing siphonic action.*

At the same time let it be most distinctly understood that I do not recommend traps, for closet or such purposes, to be fixed so large, nor without proper ventilation.

The Principle of Siphonage in Traps.

[*Also see Air Pipes.*]

The reason why siphonage takes place in ∽-traps is on account of the difference in the weight of the water between the inlet and the outlet of the trap, which will be readily

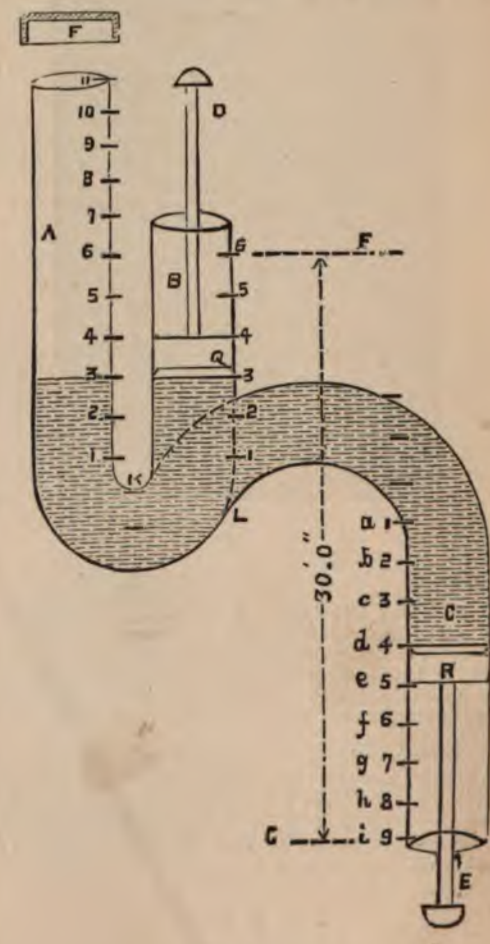


FIG. 285.

understood on reference to Fig. 285. Here A is the inlet, C the outlet, and B the air-pipe. Suppose that the trap is full of water from the piston R, to the piston Q, and up to the gauge line 3 in the inlet pipe A; and that the water in A is in a state of rest, and open to the atmosphere, which presses upon the surface of the water with a pressure equal to 15lbs. on the square inch, and that this atmospheric pressure is also acting upon the outward end of the pistons Q and R. The pressure being equal, and,

so long as the piston R, is held up with sufficient weight to *balance* the column, the water in the inlet pipes, A and B, will stand at one level. But suppose we add an extra pressure of 2lbs to the square inch to the piston Q, at the same time keeping the piston R, stationary; this will cause the piston Q, to descend, when the extra pressure given to the water in B and A will overcome the 15lbs. external atmospheric pressure, and the water in the inlet pipe will rise up to the line 5, because each division is 2ft. distant. Now, supposing each division of the pipe A, to be 2ft. apart, it is then plain that the water must necessarily rise to the above level, because we will say, in round numbers (which is near enough for our purpose), that the pressure or weight at the bottom of a column of water 1ft. in height is half a pound. This is what is meant by 15lbs. atmospheric pressure to the 30ft. column of water; and, as before stated, the pressure of the atmosphere, as everyone should know, equals about 15lbs. to the square inch upon the earth's surface. Now, pull the bottom of the piston, Q, which is now, say, at line 1, up to the gauge-line 5, which produces an eight ft. column of water in pipe B above that in A. By so doing you take a portion of the weight of the atmosphere away from the surface of the water in pipe B,—this represents the sucking action before explained—causing the external atmospheric pressure in the pipe A to press the water down to the gauge-line 1, and to keep it there as long as the 4lbs. or sucking action weight per square inch is taken off the surface of the water in pipe B, or held off from the bottom of the piston Q. Now add an additional inward pressure to the bottom piston R, to the extent of 2lbs. to the square inch in excess of the weight of water in the pipe C; this will cause the water in the pipe A to rise from 1 to 3. Next push the piston Q from 5 down to 3; this will cause the water in pipe A to rise to 5. Keep the piston Q stationary, and suddenly remove the piston R from the pipe C. This will, so to speak, take the prop away from the water, when it will fall, and rush forward in proportion to its weight, and the air rushing in behind in proportion to this additional weight causing the difference of weight which, in reality, constitutes siphonic action. Next place an air-tight cover, F, over the end of the pipe A, and place the end of the pipe C into water; then draw up the piston Q; this will remove the atmospheric pressure from the internal parts of the pipe: by so doing the water at the mouth of the pipe E will, by the external 15lbs. to the square inch atmospheric pressure, known as suction, be forced up the pipe, and rise to the height of about 30ft., or from the line G to about the dotted line F, or in proportion to the weight applied to the piston Q, or until it stands at a height of 30ft., this being the limit of the 15lbs. external power, or atmospheric pressure. Now pull the piston Q right out of the pipe B; then let go the piston R, and the air will rush in at the pipe B, which has become the air pipe, and so allow the water in the pipe C to fall back to its former static or quiescent state. It is now very plain that at that moment the pipe B in reality becomes an air-pipe; and if, instead of pulling out the piston, you had taken off the cap from the top of the pipe A, this would have admitted the air, thereby causing it to become an air-pipe, and which would have caused the water in the pipe C to have run back, plainly illustrating siphonic action.

Air Pipes.

I have explained that the half ∽-trap can be made proof against momenta, and that some traps require an air-pipe, but I have not yet explained the size, or in what position the air-pipe should be fixed; therefore, now the question is, at what point of the trap will it be most advisable to fix the air-pipe. Turn back to Fig. 264, also examine Figs. 265, 266, 273, and 274, and notice in which direction the water will strike in these particular diagrams. The arrows in this trap, Fig. 273, indicate the direction it will strike the top of the trap between L and *d*, consequently this is not the place to fix it, for, if fixed here, the soil, &c., will clog up the pipe, and so render it useless. Now examine Fig. 274, at *a*. At this point the water does not touch when the trap is running full bore, but it tends to draw inwards, which converging currents of water will be in accordance with the contour of the pipe, but at *b* and *d* the water gives an outward thrust upon the pipe, and, therefore, at these points the air will be of less value. But it must be borne in mind that, if the shape of the trap is that of Fig. 278, this converging current will be in another part of the trap, because the water will be made to press upon the outward curve at M, and this curve being made to protrude inward, the water will tend to curl itself up in a centripetal manner towards *a*, and will be reflected towards M, especially when not running full bore. Next, speaking of converging current of water when passing through bends, it may be well here to state, that it has much about the same effect, save the friction, as that of water when passing through a circular opening, which, for simplicity, may be seen as follows: Take an ordinary pail, and bore a ¾in. or 1in. hole in its bottom, close it with a plug, fill the pail with water and withdraw the plug. Now, on examining the descending column of water, it will be found to be contracted or tapered for a short distance below the hole. This contraction in the stream will be in its length equal to a distance of half the diameter of the orifice, and will much interfere with the amount of water which should pass this orifice; and notice that the same effect is produced, whether the hole be *in the bottom or side of the pail.* (To avoid this contraction, we, with a turnpin, open the ends of the pipes before soldering them to the cisterns, and if well opened, to about double their diameter, then we can, through the same sized pipe, with a constant head, get a larger quantity of water,) and if, instead of a plain opening in the pail, a pipe be inserted, whose inlet is, as before said, tapering internally into the pipe opening, the flow of water will be increased to about 80 per cent., and if this pipe be also slightly tapering outwards, the flow of water will be even greater, which may be accounted for by the easy way in which the water enters the pipe, *versus* that of an abrupt edge, the latter of which puts the molecules of water into a very agitated, whirling, or spinning condition, which, in collision with the issuing stream, destroys a portion of its own velocity, and so causes it to become contracted.

Now there will be the question in your mind as to what is the proper size for the air-pipe. (This is not a ventilating pipe as generally understood in sanitary plumbing, for the term, "ventilating pipe," is generally understood to be an exhaust pipe for carrying off obnoxious gases.) The answer is, in a siphonic point of view only, that the size of pipe should be in proportion to the downward length of soil, or waste pipe, and in proportion also to the fall of the column of water, or water plug, or piston. For ordinary practical work, when the fall does not exceed four times the length of the air-pipe, then the air-pipe will answer well, if made to one quarter the *area* of the soil, or waste pipe—that is to say, a 4in. pipe, 40ft. long, should have a 2in. pipe only 10ft. long; but if the air-pipe be of a greater length, then its bore must be increased in diameter to allow for extra friction. Thus, suppose the friction in 10ft. of air-pipe to be one, then the friction in 20ft. of air-pipe would be two, and so on.

Air Pipe Bends.

Bends, as shown in the illustration of the traps, Fig. 286, &c., greatly retard the flow of liquids or fluids, when passing through pipes, and, therefore, should be as much

as possible avoided. Of course, if you choose to use larger pipes than are actually necessary for the work, then the effect of these bends will only be felt in proportion to size of pipe.

FIG. 286.

In the case of a continous spiral pipe, as illustrated at Fig. 286, in which there are no checks, this contraction is unnoticeable, as the fluid, as it were, whirls, spins, or glides round the external part, figuratively speaking, not touching the inner surfaces, and therefore meets with no opposing force, save and except friction, which, as a matter of course is very great at the outer edges, as at A, B, C, D, &c.

FIG. 287.

Consequently, in experimenting to find these effects, a continuous spiral bend must not be used, but one as illustrated at Fig. 287.

The Action of Wind Currents on Traps.

Sometimes, when the pipes are fixed so as to allow strong currents of wind to pass through them for 10 or 12 hours together, the water within ∽ or V-traps will be considerably agitated, and will by its rocking motion and fluctuation ebb out to the extent of the waterlock of the trap; consequently the trap becomes useless, more especially in the winter months. This is particularly noticeable in all siphons, *i.e.*, in traps made on the ∽ and V principle. But when the D-trap is used, the effect of the wind blowing flatly upon the surface of the water is very different, inasmuch as the water within the trap is, so to speak, pressed more equally, as may be seen by blowing through the tube F, Fig. 280, and consequently this wind action on the water within the D-trap is reduced to a minimum.

Bottle Traps (Continued).

This trap, as may be seen, is exactly the same as those shown at Figs. 281, 282, 283, 284, excepting that in the figure 288 a stump is branched in at A which answers for the overflow of a lavatory basin, and which should be branched in below the water line. C is the cleansing cap and screw.

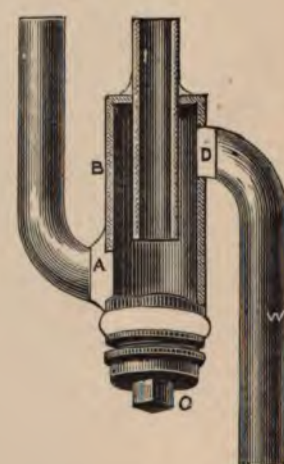


FIG. 288.

In fixing all traps of this description (or, indeed, any traps that are required to be self-cleansing), always fix them not less than 18in. below the washer and plug of the basin or strainer of the sink. Then, if the washer and plug, or grating, is large enough, which it is very important that it should be, to admit sufficient water to fill the pipe *full bore*, the weight of the water falling upon the bottom of the trap will send all sedimentary matter before it. I have fixed these traps upon the floor-line, in order to get a good fall from a washing-basin, and for the purpose of cleaning it out fixed the cap and screw C on the side or in front

Sometimes this trap is made as follows, see Fig. 289, C F forming the cap and screw, and a floating ball may be employed as at B, which some people claim as an advantage for keeping back gaseous fluids from the internal side of the dip.

The top part, I E and W, is cast in one piece of lead, and the bottom C is made to screw on at F. C is generally made of glass, which I venture to suggest is very much against the efficacy of the trap, as under extreme temperature of either heat or cold (for instance, careless persons

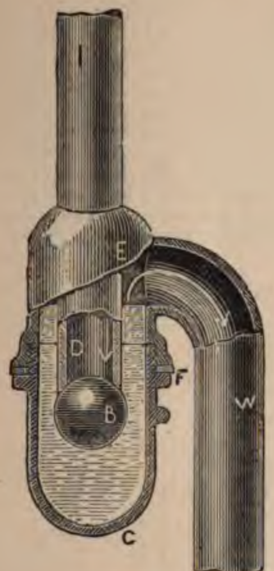


FIG 289.

throwing down hot water in very cold weather) glass is very apt to break, and the glass once broken the trap no longer exists, but becomes a highly dangerous article.

The shell of this trap possesses no advantages over Fig. 288, neither is there any superiority in the trap. Many modifications of this bottle trap are to be found about the country, some answering for wash-basins, others for sinks, baths, &c.; they are known by the name of branch pipe

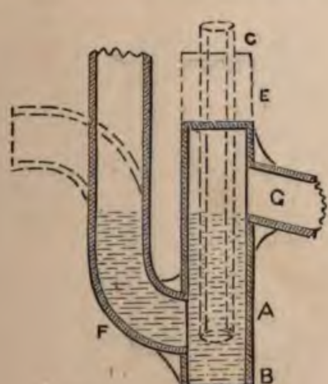


FIG. 290.

traps, and other such appropriate titles, and Fig. 290 will, by the dotted lines, &c., serve to illustrate the many different ways in which the trap may be made useful for sinks, wash-basins, baths, &c.; it is made with a short-length of suitable-sized pipe for the body A, either with or without a cap and screw at the bottom B. The top may have a pipe to enter and form a dip as shown by the dotted line C, or the top may be open to receive an air-pipe as the dotted line E. Or the inlet may be formed as shown by the pipe F, at a suitable distance below the outlet pipe G. Of course, these pipes may be twisted or bent to any shape, or F may be the inlet or the outlet, according as circumstances require it. I give you these traps so that you may never be at a loss when circumstances call for your judgment in selecting a trap to suit your work. This trap works well for a lot of odd jobs, such as wash-basins. When the cap and screw is introduced, the pipe F answers for the overflow, and the pipe E forms the washer and plug. You will notice that, of course, this trap is in shape and make like my bottle or soap-trap, from which it is taken.

Fig. 291 illustrates a kind of branch-pipe trap, which is, I think, one of the simplest forms and make that it is possible to conceive for a stink trap, and will be found wonderfully useful on account of its cheapness and the readiness with which it can be made from material always at hand in the plumber's shop.

It can be made, as shown, with a rounded bottom B or a piece of lead soldered on to the bottom like a flange. It will

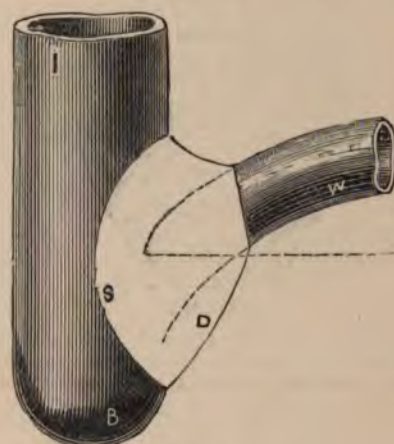


FIG. 291.

be found very convenient for fixing under "Fell's" or "Shanks'" cast-iron baths. I, is the inlet which may be a piece of, say, 3in. lead pipe, about 9in. long, though in many cases only a 1in. pipe is amply sufficient. W is the waste-pipe, which for "Fell's Bath" should be 1½in., and can be soldered within 2in. of the bottom, as at S, and fixed on the S plug as per dotted line D, then bent up to run along the joist, &c., &c. It will, of course, be understood that when the trap is used for bath work having a safe, the trap and safe may be soldered down in the usual manner; but when the trap is used for washing-basin or sink work, a cap and screw should be fixed in the bottom, which, properly, ought to be selected the right size to fit the bottom of the pipe or trap, without working or soldering the bottom over.

I have tested the working of this trap and found it perfect, excepting in the matter of siphonage, which is counteracted by the application of the air-pipe fixed at about W, or by the dribblings which always necessarily follow from baths, or other articles having bottoms with large surfaces.

Royal Palace Sink Trap and Cone.

Fig. 292 illustrates a very good and reliable sink trap; in action it is that of an ∽-trap, but is constructed in such a manner that it cannot elb or wave out, nor can it siphon its water seal away owing to the shape of the diaphragms H I. It holds by far less water than any other trap

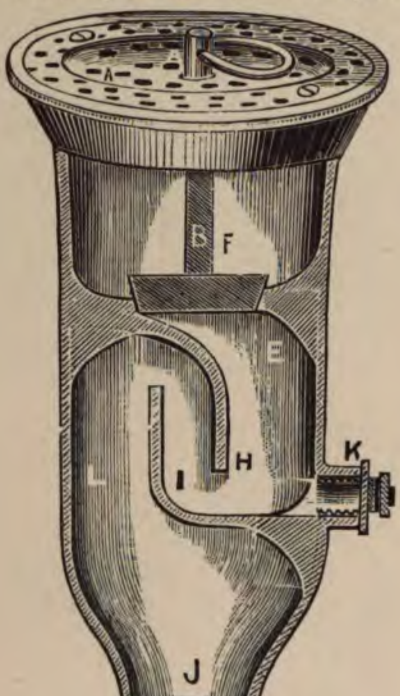


FIG. 292.

having the same water-way and seal, and, as can be seen, may be fitted with a valve with grating above. It is acknowledged by all practical plumbers to be a long-felt requisite, especially for butler's pantry sinks, and from a sanitary point of view is perfection; for here the sink is allowed to fill up, and a full way pipe of water is allowed to instantly flush the drains. It is also good in places where no water is thrown down for months together, for if the valve is down and the trap dry no smell can possibly pass through the trap.

This trap when fitted with the valve is very useful for fitting in cottage sinks, for with it the ordinary sink can at any time be converted into a washing tray, &c. The above is drawn from the 2in., which is cast in one piece and weighs 9½lbs. They are made to suit gratings in sizes of 2½in., 3in., 3½in. and 4in., and are as simple as a bell-trap to fix. To be had of Messrs. Farmiloe, Lead Merchants.

There is also a first-rate grating fitted with these traps which would let quite double the quantity of water pass as any other 4in. sink grating I have ever seen. The grating is also fixed with two screws. The valve is held up by simply letting the ring turn over, as shown at A, Fig. 292.

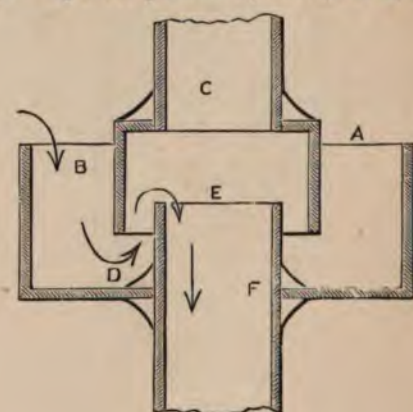
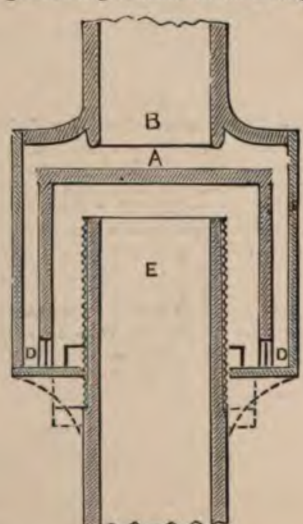
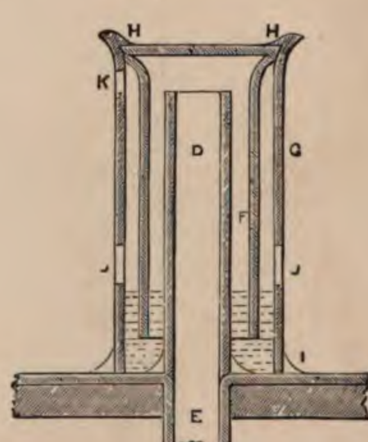


FIG. 293.

Ventilating Trap.

This trap is chiefly used in roof work where a ventilating pipe passes through say a cesspool, and the diagram is too simple to require further explanation.



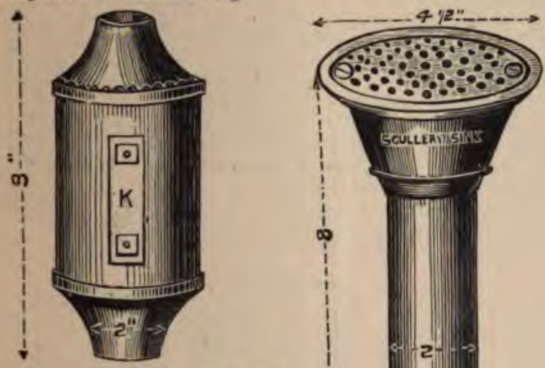


Perpetual Water or Tube Trap.

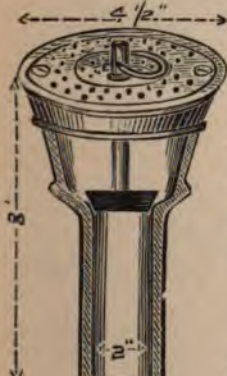
This trap is used as a waste-pipe trap for fixing in closet-*cisterns, &c., but although a good and perpetual trap it must be looked upon with a suspicious eye* from a sanitary *point of view. The diagram explains itself*; except that the two holes in the outer tube near bottom must not be large enough to supply the pipe D E full bore, or you will some day find the cistern siphoned out; K is the air-hole to prevent siphonage in the ordinary way, and which hole K must be always put in.

B, Fig. 298, illustrates the R.P. (Royal Palace) trap, Fig. 292, with closed top and bottom for soldering to waste pipes, such as sink pipes, lavatory basins, &c., and is a capital trap at a very low price, 1½in. and equal to 10lbs. lead throughout, being only 2s. each.

D is a sink cone and grating which you can solder on the trap after or before fixing.



B FIG. 298. D



E

E is the same thing, but filled with a valve below the grating for butler's pantry sinks, washing trays, &c.; the tail pipes are about 6in. long, and plenty long enough to wipe to trap of any kind below the sink. The prices of these are marvellously low for so good an article, and are kept by all respectable lead and plumbers' brass merchants.

The Oval Lip-rap.

This trap is shown at Figs. 295 and 296. The latter illustrates the trap suitable for fixing in a chase, whilst the former illustrates

FIG. 295.

FIG. 296.

the outgo as at W, and after what I have said on Traps, these will require no further description. They are made by Jennings' people.

The Lip-Trap.

The lip-trap, Fig. 297, is sometimes known as Antill's trap. This is another trap partially made up with the bell-

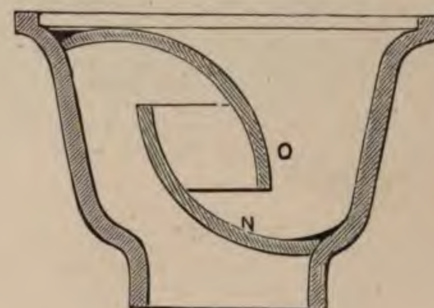


FIG. 297.

trap body. This trap is sometimes cast in one piece, and at other times cast with the bottom lip N and the body together, and sometimes the lips N and O are soldered in. In fact, any ordinary workman having the bell-trap body can easily solder the two lips in and at once make a lip-trap. I rather like this trap for ordinary work, but it should never have too little dip, which is the usual fault in ready-made traps. I have a set of moulds to cast these lips separately and to shape; the action is too simple to need description. If this trap has a cone fixed on its top, connected with a pipe, it may be fixed any distance away from the sink, say 18in. below. By fixing it in this manner the sedimentary matter is much better cleared; the trap then becomes the same as Fig. 296.

Concentrated Cone Trap.

This new patent of Jennings', which you have represented

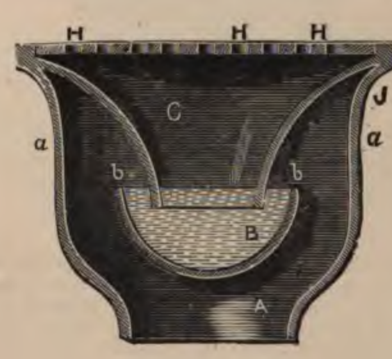


FIG. 299.

in Fig. 299, is especially efficacious in places where it has been customary to use the bell trap.

The new patent concentrating cone trap has a fixed

12

inverted bell, B, Fig. 299, and a $\frac{3}{4}$ bell-shaped cone, C, which forms the dip of the trap, and diverts the stream from the grating-holes, H, H, H, to the centre of the inverted bell, thereby concentrating the separated flow or small stream into one point, which at once renders this trap a very good one.

Fixing the above Trap below the Sink.

If this trap grating be taken off and a length of pipe wiped on round the top, this trap may be fixed below the sink, or below a washhand basin, &c.; if so fixed, the rush, or fall of water into the bell, or bowl, will drive all sedimentary matter before it, and so the trap will keep in good working order. The lip trap Fig. 297 may also be fixed as above directed.

Bell Traps.

These traps are illustrated at Figs. 300 and 301. They have been very extensively used for sinks, area-drains, &c., and

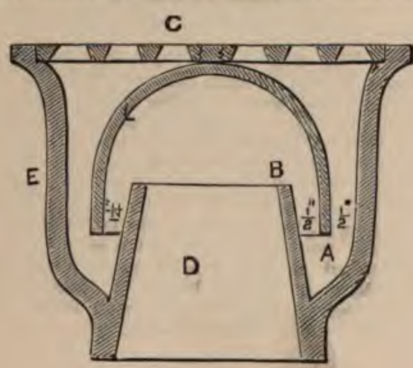


FIG. 300.

FIG. 301

owing to their being so very badly and ill-proportionately made, they are almost universally condemned; however, as my work would not be complete without noticing them, I have shewn them as they should be made, but first let me explain how they are made. First, generally speaking they have not sufficient dip at or between the mouth of the brass bell A and the outlet pipe B. This is no fault of the invention, but that of the maker. Secondly, it is generally made too small between the outlet stand-pipe D and the bell passage, and the outside or lead part of the trap to clear itself, therefore it is against all reason to expect it to pass large matter. This should not condemn the invention. Thirdly, its grating C is often taken off through the second cause, or that it will not pass the large matter through the grating (some people would push a saucepan through), but this can be easily remedied by the lock grating. So that for the three so-called evils there can be remedies. But by no means use this trap until you know that this is done. The bell is screwed on to the grating at G.

The proper size for a bell trap: The pipe D should never be less than 1in., there should always be at least a clear $\frac{1}{2}$in. space between the outside of the bell and the body E: also between the inside of the bell and the outside of the outlet pipe D; and the bell should have at the very least $1\frac{1}{4}$in. dip into the water, or between A and B; and if possible, the taps which supply the traps should always drip, say, two or three spots per minute, which will keep the water from stinking. In fact, all traps should have a constant supply of fresh water.

Fig. 301 shows the water line at D and the bell dipping thereinto, the arrows indicate the gas from drain, &c.

Fig. 302 is an elevation of the bell trap.

FIG. 302

FIG. 303. FIG. 304.

Fig. 303 is an elevation of the bell trap, showing it with a fixed hinged grating.

Fig. 304 is an Antill's trap, fixed with a lock grating with key above.

Soldering on Bell Traps.

I may here give you the directions for fixing these bell traps. First, with your turnpin open your pipe to just fit it on and over the hub or bottom part of the trap, then rasp the outer edge of the pipe, soil and shave it about 1in. long, next soil the outside of the trap all over and shave it just over the shoulder, as at A, Fig. 300; turn the trap grating downwards, and wipe your joint upright. When soldering into the bottom of lead sinks, see that the wood work is dished down so that the trap may be let down on the top of the lead at least $\frac{1}{2}$ of an inch below the level of the bottom of the sink, then soil the lead round about 3 or 4 inches past your shaving line, next shave the lead and top edge of the bell trap, and "touch" it; then you will require a nice piece of brown paper, cut to the exact size of

the brass grating, which should be pasted upon the grating; this will prevent the solder running through your grating when it is being soldered down. Some plumbers "touch" over the brass grating before putting the pasted paper on; this allows the paper to be readily taken off after soldering on.

Cementing Sink Pipes to Stone Sinks.

For fixing these bell traps in stone sinks, thoroughly clean the grease off the lead, wet your sink hole, and insert the trap and pipe to its proper level, after which thoroughly fill up the hole and round your trap with neat Portland cement, and see that it does not give way before it is properly set.

Bell Trap Moulds.

[*Also Moulds for Sink Cones.*]

The bell trap mould is an exceedingly useful article, for making cones for connecting other traps to the gratings of sinks. I will herewith describe and illustrate the method of casting, which is as follows: F, Fig. 305, is a gun metal block which forms the inside. G is the pin or plug which forms the stand-up pipe D, Fig. 300. This is made to fit into the block F—not too tightly. H is the cover, or part which

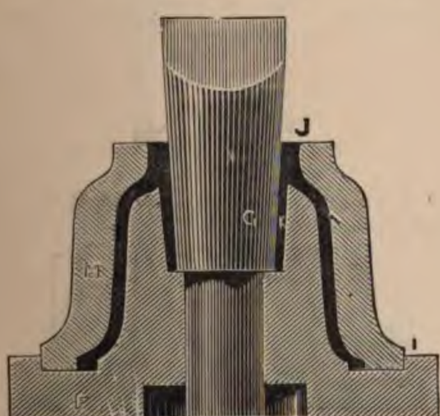


FIG. 305.

gives shape to the outside of the bell-trap. This is turned to fit the block F, as shown at I, when the mould is complete.

Casting Bell Traps.

This is boy's work, but I know a lot of plumbers who never saw a bell-trap mould, let alone having worked one. However, there is no art in this job. First, put your mould together as at Fig. 305, make the lot hot, then touch it all over the inside. Put the mould again together, and pour the lead in at J, when it will run into the stand-pipe at K, and then the body will fill, and soon sets. Then knock out the pin or plug G, and take off the cover H, and the body of the trap is made. You may have to cast four or five before the moulds are to the proper heat, but keep at it until all goes smooth. The secret is, as in all other lead casting, in the moulds (or "chills" as they are sometimes called) being kept to one heat, which can be done by a very little practice. Iron moulds are no use for this work, and the lead must not be too hot, or the trap will break in cooling.

It often happens that the plumber or lead-worker casts for the brass finishers at so much per cwt. Of course, good cast bell-traps have no holes or other irregularities on their surface, and should not be too thick, three-sixteenths of an inch is plenty, and ¼inch round top rim for the grating.

Sometimes the body of this trap is cast without the stand-pipe D, for sinks not requiring the trap, &c., or for making other kinds of traps. When this is wanted, have another plug G made to fit the top part of the block F, or you can have the block F and plug in one piece, but remember to have the delivery all one way—that is, let the slope of the block F from the dotted line continue in the reverse way to that of the plug. Of course, this stops off the lead from forming the stand-pipe D.

Brass Gratings.

I do not know anything more important in connection with sink work than that of having the brass gratings made in proper proportions, with sufficient holes of proper size and quantity capable of delivering at least twice the quantity of water than that which the waste pipe is supposed to discharge when running full bore. These holes should be made taper from the under side, as shown in Fig. 306, in which it will be noticed that they are countersunk from the bottom side. The bevel on the outer rim should be bevelled from the top side, and not as shown in Fig. 306. Fig. 307 shows the top side, as also a strainer, fixed with screws marked A B, the section of which is shown at Fig. 308.

FIG. 306.

FIG. 307.

As a rule, the strainer should have a sufficient quantity of holes, and *large enough* to twice fill up the waste pipe. This is to allow for stoppages, &c. Suppose the dip-pipe to be 1in. square, then there will be an equal area to this pipe of 16 quarter inch and twice this will be 32; therefore the grating should have 32 quarter inch holes for this size trap. But suppose we say three rings—the first to contain 5 holes, the second 11 holes, and the third 13 holes; the

first ring should be 1 in. outside diameter; the second $1\frac{3}{4}$ in., the third $2\frac{1}{2}$in. This makes a grating $2\frac{1}{2}$in. over, having 29 quarter inch holes, which is that of my pattern.

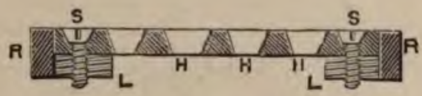


FIG. 308.

Tye and Andrews' Trap.

This trap as represented in Fig. 309, is made after the S-trap pattern, but has an improved lock-grating, which consists in the adoption of the well-known bayonet-joint, as shown at A. The grating shown in Fig. 310 is different in this respect, that it has a screw, as shown in

FIG. 309

FIG. 310.

the sectioned part at B. These traps being made of iron, are of course useless for watercloset work.

The Ball-Trap.

This trap, Fig. 311, is only two bell-trap bodies soldered together at P, with a cap and screw Q, and the pipe R pushed through the one end, which may be either inlet or outlet. S is the other aperture. This trap is worked, as before stated, either way. If used as now shown the ball forms the trap, and does not want the water-lock, although it may be made so to work. Turn this trap the other way about, that is upside down, and the pipe R, which should be cut true, will form a dip-pipe, and the ball, if made of light materials, will swim and try to block up the waterway, which it will effectually do at times, to say nothing of the hindrance of the water through R, and in fact, if the ball be very light, and a good depth of water, it will require some force to remove same. This trap is very handy as a tidal-trap—in fact it was originally made for this purpose, as, if the pipe S be connected with a drain leading from the cellar to the basement closet, and the ball made to float, this shuts off the tide water from all over the house. A large india-rubber foot-ball, placed in a good-sized D or P trap, to float against the dip, answers the purpose admirably. The rubber should be as pure as it can be had, and will work the better. This trap is handy for all sorts of work and is very easy to make. The ball is dropped in through the cap and screw; but in this trap there is nothing new. Jennings has made traps to work on this principle many years ago.

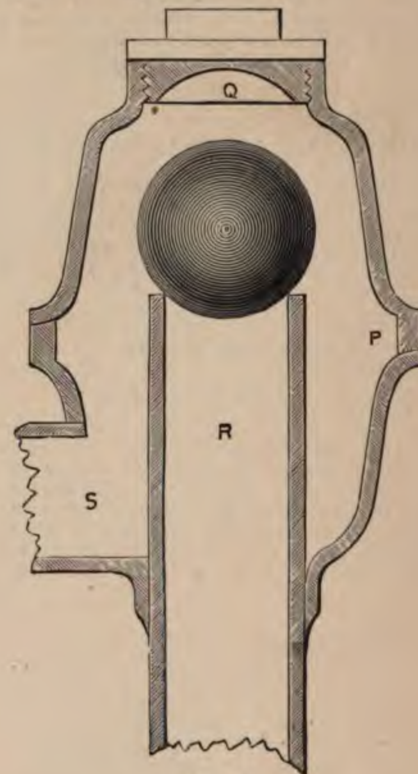


FIG. 311.

Fig. 312 is a simple ball-trap, as shown in one of my patents of 1876, attached to the overflow of a valve-closet.

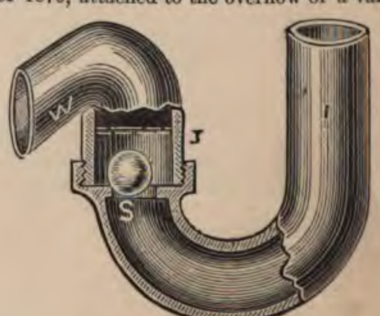


FIG. 312.

This trap, which is shown upside down, is made as follows: It was cast in one piece, as also the pipe I, but straight; this had the seating S cast upon it. It was cast in a mould something like a Couburge mould, the ball dropped in, and the trap sometimes soldered at J with a copper bit, &c. If the ball were required to float, a light ball was used, the pipe I left straight, and the other way up; but on the other hand, if the ball is too heavy to float, the trap is formed in the pipe I.

In any case I is always the inlet.

Mr. Buchan's Ball-Trap.

This trap in principle is the same as the last described; but, as shown at T C, has a cap and screw, also at C and

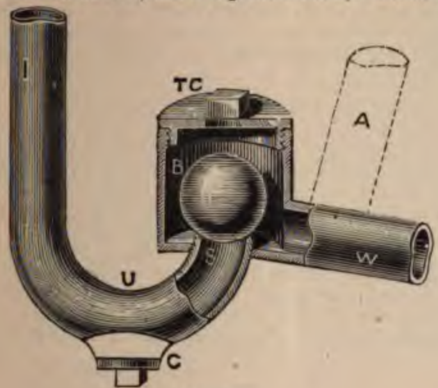


FIG. 313.

the vent-pipe A. The manner of making this trap is the same as described in reference to Figs. 312, &c.

Jennings' Ball-Trap.

Mr. G. Jennings was one of the first to use a ball inside a trap; his first patent is dated 1871. Another, and that which he considers a great improvement on the first, is dated 1878.

An examination of Fig. 314 will show you a rubber seating which allows the ball to seat itself perfectly air-tight, the water in the lower lip, and the guide to keep his ball in its place.

FIG. 314.

CISTERNS.

Cisterns Ancient and Modern.

There are many of the old cisterns in constant use at the present time which serve a twofold purpose: they answer the original use for which they were formed, and they stand as everlasting memorials of the very highest interest, in many instances pointing out to us the most celebrated cities of antiquity. How little now remains of that ancient city of Persepolis, its columns and its sculptures. They are crumbling and changing into dust; all is gradually disappearing; still the cisterns stand just as of old, defying the ravages of time, and, if not disturbed by artificial means, will remain for thousands of years as monuments, exciting the curiosity of the beholder; and the deep-thinking powers of the future antiquarian. Ephesus is no more, but it will be found that some of the marble sarcophagi, or coffins used for the interment of the dead, are still in existence, answering the purposes of cisterns and watering-troughs for cattle. Again we read, both in sacred and profane history, of enormous metal vases for water storage—for instance, the celebrated Brazen Sea cast for Solomon was 16ft. diameter, and about 9ft. deep, splendidly decorated with cast flowers, lilies, &c., 1015 B.C. [See 2 Chronicles, c. iv. v. 1 to 8; also 1 Kings, c. vii. v. 23.] Herodotus mentions cisterns of gold and silver of very large dimensions. Cisterns were also used in the oldest citadels of Greece in connection with the fountains of Bounarbashi, locating the palace of Priam, and the site of ancient Troy; we also find cisterns in ancient Peru and Chili. In India we find cisterns made of enormous size, also in Egypt; and in Rome, near the Baths of Titus, may be seen to this day nine large underground cisterns, constructed thousands of years ago. After perusing these few facts, it would be idle to suppose that my readers will take much notice of those cisterns only five or six hundred years old, such as were made of lead at Paddington in the year 1285. Some of these I shall illustrate at the end of this article on cisterns. I shall, therefore, now proceed to explain those of modern make.

The Romans well knew, and so should we also, that cisterns should always be fixed in such a position that they may be protected from the frost of winter, and from the heat of the sun in summer.

Rain Water Supply and Storage.

[*Also see Water Supply, Filtration, &c.*]

In some parts of the country where there is no town water-supply, nor wells, brooks, or springs, the source of water storage is a matter of no small consideration. In such districts we have to depend upon the roof for supply. This being so, the cistern should be large, and of sufficient capacity to contain the necessary quantity for a supply for at least fifteen or sixteen weeks together. It is not generally known that the quantity of rain-water falling upon the surface or roof of a *slated* house, is ample for the ordinary supply of that house. I have on many occasions provided such cisternage, and always with satisfactory results; but, before you can do this, it will be necessary for you to consider and find out what will be the

approximate quantity of rainfall during the year. It is easy enough to find a record of the rainfall for each year, and it is a well-known fact that in some parts of England we get more rainfall than in others—for instance, the mean rainfall in England is 31¼in., viz: if it was allowed to stand where it fell it would in the end of one twelve months measure 31¼in. in depth, or on one acre of land we should get 706,937 gallons of water, but in London it is only 25in., Upminster in Essex 19½in. In Stye, at the very head of Borrowdale in Cumberland, the wettest spot in England, the rainfall is 165in.; in Manchester, 38in.; Bristol, 32in.; Hastings, 32in.; Ventnor, 26in.; Lyndon, 26in.; Chatsworth, 28in.; Plymouth, 46in.; Liverpool, 38in.; Lancaster, 40in.; Keswick, 68in.; Coniston 64in. There is also a difference between the rainfall, caused by the seasons. The average wettest time is: Autumn, 9½in.; summer, 8¼in.; winter, 7¼in.; spring 6¼in. On the average October is the wettest month, and April is the driest, although it is noted for showers.

In England seldom a month passes without rain, little or much; but it must be remembered that several months may pass over without giving any rain available for water supply, and on the other hand more rain may fall within one hour than is required for one month's supply; this is proved by the extraordinary rain of 26th July, 1867, when the fall at Deptford was 3·16in. and at Greenwich 3·07in. The wettest year known at Stye gave 220in.; the driest, 110in.; mean, 165—more than six times as much as in London, or eight times as much as in the midland counties. Then, again, a cold night and a bright morning will often, by condensation, &c., give water to our slated roofs, which must not be lost sight of. With this, in conjunction with the rain supply, we can make sure of having water sufficient for any ordinary country house, and therefore the cisternage must be made accordingly. Let us suppose the roof of the house to be, as my own, 40ft. by 21ft., equals 840ft. super; suppose the rainfall to be 36in. or 3ft. during the year, here we get no less than 2,520 cubic feet of water, which equals 15,435 gallons. Now allowing one pint to the cubic foot for waste, then we have left 15,120 gallons, to say nothing of the condensed water, which will be at times considerable. Now, suppose we make our cisterns to hold sufficient for a three months' supply, or a little over, then the cisterns must hold at least 4,000 gallons, or rather over quarter of 15,120. I have always worked to this rule, and have found it to work satisfactorily, and on several occasions have had sufficient water to supply water closet and farm house. Before using lead to line a cistern you should know whether the water is free from chemicals which have an affinity for lead, or to simplify matters in other words, you should find out whether it is of a chalybeate (or what is known in the plumbing world, of a "Charley Bates") character, or not, for with certain waters the lead will quickly corrode away; at other times the tin in the solder will be attacked in a similar manner. In fact, I have seen a 7lb. lead eaten into holes within twelve months after fixing. I have also seen the solder in the same condition within three months after fixing; in this last case, the lead should be burned together, while in the former the lead can be protected by giving it a coat of lime whitewash, or one of cement (fat, resin), or sometimes tar and pitch; but where lead cisterns cannot be employed perhaps iron may, but the iron rusts through being alternately wet and dry, and so scales of iron are continually dropping into the water, which is bad. Some people enamel the iron, but this is not to be relied upon. Galvanized iron perhaps may stand, but it must be remembered that there is water which will attack zinc or galvanized work equally as it does lead. Of course in galvanizing the iron has only a mere coating of zinc, which is soon dissolved by soft or rain water, and which is easily introduced into our system in very small quantities, which change the nature of our tissues, and injure the nutrition of the organs, in consequence of chemical reactions which take place during the passing of the zinc through the organs. The result is cerebro-spinal and genito-urinary afflictions, ancemia, dyspepsia, pseudo typhoid fever, and other diseases of which, often, the origin cannot be traced.

Slate Cisterns.

These cisterns have been largely used, but they are apt to crack in the winter [see Slate Cistern, Fig. 314], besides in this class of cistern a kind of green stringy vegetation seems to thrive, and perhaps for culinary purposes, on the whole, stoneware cisterns are the best; and where a constant supply is given, or where the storage is only required to be from eighty to two hundred gallons, these cisterns may be employed; or larger supplies may be obtained by increasing the number of cisterns and connecting them with short lengths of pipe (or by the use of the Wirtemburg siphon [see Fig. 104], and allowing the supply to run into number one, and passing through all the others before being drawn off). This will ensure the constant change of water through the cistern, which is of the greatest importance.

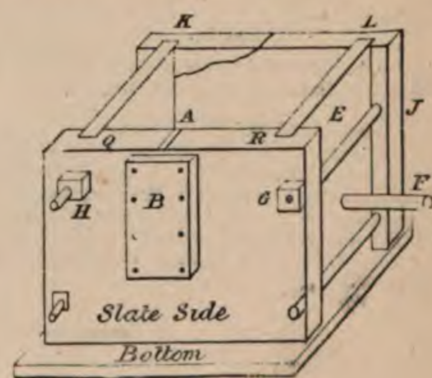


FIG. 314.

Underground Tanks.

In country places, such as farms, &c., where the water is obtained from roofs, large underground tanks, made circular to withstand external pressure, are sometimes constructed. The ground is usually dug out and bricked round, after which the brickwork is cemented with good Portland and sand. These underground tanks will last for ages, and I think that this is unquestionably one of the best methods for storing the precious fluid, because the water is kept cool in summer, and warm in winter. Of course, the tank should be made so that it can be easily cleaned, and a pump fixed for withdrawing the water.

There is another reason why these tanks are suitable, and that is, they can be built from five to thirty feet or so in diameter with comparatively small outlay.

[See Water Storage, Domestic Water Supply, Filtration. Town and other Water Supply, Pump Supply, &c.]

Position for Cisterns.

This is a matter which most builders seem to ignore; any place is by some considered good enough for the cistern. I suppose this is from the fact that it is rarely seen. How-

ever, there is a place for everything, and let us have everything in its place. The cistern room should be away from all stinks, it should be warm in the winter and cool in the summer, and it should be well ventilated, but not so as to have the cold winds of the winter blowing through it; a window which can be *closed up* with shutters should be fixed. If for slate or iron cisterns a leaden tray or safe should be fixed under the bottom, and such cisterns should rest on quartering or joist, in order that the fittings may be screwed up, and to allow for examination, &c. The cisterns should have trumpet mouth standing waste pipes, with ground in washers, in order that they may be cleaned out. [See T S, Fig. 477, and 3, 9, Fig. 339].

All cistern bottoms should stand ½in. in 5ft. out of the level, falling towards the waste pipe, in order that the dirty water, when stirred up whilst being cleaned out, might run towards this waste. All draw off pipes taken from the bottom should stand up into the cistern at least ¾in., having their ends opened trumpet shaped, and if hot water supply pipes are taken from this cistern always manage it so as to fix them with their mouths an inch or two below the other draw off pipes. This insures a little supply of hot water when there is none at the cold water cocks.

[For Filtration of Water see Cold Water Supply].

Cistern Lining.

I shall proceed with this step by step, in the following working manner:—

Suppose the cistern to be a small one, as shown at Fig. 315—say, 2ft. 7½in. square and 1ft. 9½in. deep, the thickness of the sides to be 1½in. boards. For the sides of this cistern we shall require a piece of lead twice 1ft. 9½in. and twice 1½in. for the turn-over at K N on the top—in all 3ft. 10in.; the bottom, B, is 2ft. 7½in.; and adding this to 3ft. 10in., will make 6ft. 5½in.; say, 2in. more for squaring up, equals 6ft. 7½in. in length. If the cistern is a square, the lead will be this size the other way; but, if not square,

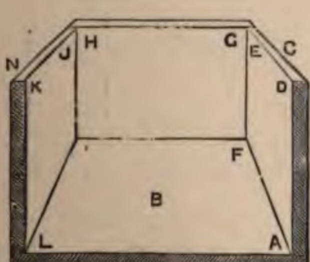


Fig. 315

add or deduct the difference of the bottom. Supposing the cistern to be lined with 6lb. sides and 7lb. bottom (the extra thickness in bottom to allow for treading upon, &c.), then the lead must be cut accordingly; that is, if you will suit your lead, cut it as follows, so as to save solder, and to have only one corner to wipe up. Measure round the side and one end; double this will give the length; allow 2in. for lapping, as shown at C J G, Fig. 326. Next take the depth: this is, say, 1ft. 9½in.; then the 1½in. for top, and take notice and allow 1in. for the bottom return lead, as shown at A, Fig 326, and at G, Fig. 320; but, in looking at this for the side return lead, as also the bottom lead, turn the drawing sideways, and sight along arrow D.

If the cistern is to be a long, shallow one—say, 10ft. long by 12in. deep, and 3ft. wide, then 10ft., and often 20ft., of solder may without any disadvantage, be saved by putting in the bottom and side or sides in one or two pieces and wiping in the two ends. To say the least, you here save 20ft. of soldering, equalling in weight say, 10lbs., and three hours' work. Of course, I do not recommend this style in awkward situations; but it should be borne in

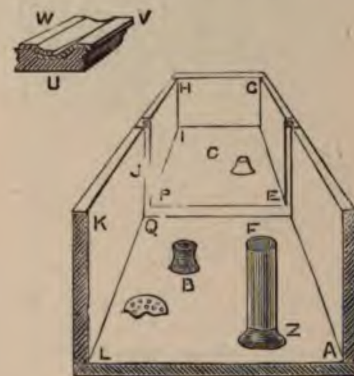


Fig. 316.

mind that by saving solder you also save time (that is, when plenty of strength is at hand), and the two combined are in many ways a desideratum of considerable importance in cistern-lining. On the other hand, it must be borne in mind that circumstances alter the work. Suppose you have a cistern too large for your pieces of lead—say, 9ft. 9in. deep, 13ft. long, and 10ft. wide: for such a cistern the depth of the side lead should be cut off the length of the sheet (one side will take nearly two-thirds of a sheet), with a joint in the middle, as at J, Fig. 316. For this joint the wood should be sunk down at least ⅜in., and 1¾in. to 2in. wide, with rounded bottom, so that the joint may be wiped flush. The sinking of this chase is shown at U V W in the above diagram; it is also well illustrated at Fig. 158. It not unfrequently happens, notwithstanding the size of the cistern, that the lead cuts very badly, or that you have a piece you would wish to use up, having no other; in these cases the chase will be found handy. The burning machine here comes in handy.

Secret Copper Bit Joints.

Some plumbers will solder the pieces together with the bit by first trueing the two edges one with the other and then rasping off the sides in such a manner that a V groove may be formed, and which they float with solder on the top of brown paper, which to a certain extent prevents the solder from running to the back; now turn the lead over so that the solder will be face downwards, and the joint when properly executed cannot be detected even by an experienced eye.

Brick, Stone, Slate, and Iron Cisterns Lined with Lead.

It often happens that cisterns other than wood have to be lined, such as a cracked slate one, or one of brick or cemented work. These materials are too cold to wipe against, and there is no good fixing for the under lead. In such cases, fix fillets of wood, about 4in. wide, 1in. thick,

and feathered off to nothing, as shown at A L, Fig. 317. This feather-edged stuff, as it is called, must be properly fixed all round the angles to be soldered, as shown in the

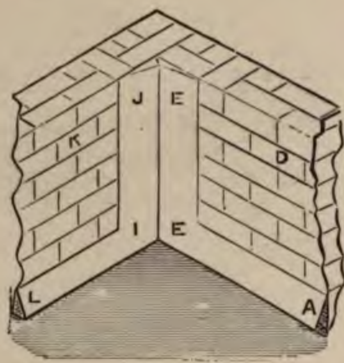


FIG. 317.

above diagram at J I L and E E A, the bottom being all wood; if not, another lot of the feather-edged stuff must be used—that is, laid flat upon the bottom, to fix the bottom return lead of the sides to, &c.

When putting the lead into such a cistern as that shown at Fig. 317, let the top part, or edge of the lead, go all over the brickwork, and turn down on the other side; or, if coping-stone is to be used, let the lead go past the first joint of the the brickwork, and fix it with large nails into the middle joint; this will prevent the side lead from bagging.

Blocking Up for New Bottoming.

Suppose it is required to put a new bottom into an old lead cistern that has been soldered all round the bottom;

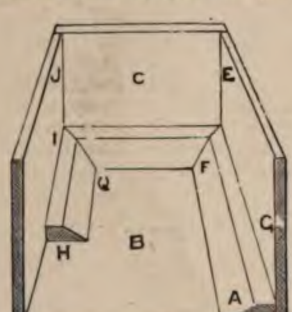


FIG. 318.

the old solder would be in your way, and should, with the chipping-knife, be cut out, usually just above the old solder [*see* Fig. 322]; then having removed the old bottom, lay some fillets or blocking all round, as shown at H I Q and F G A, Fig. 318. The size of this blocking must be governed by circumstances. Suppose the flat part that rests upon the bottom to be 6in., the back 1½in., flat part on top 2in., which will leave 4¼in. play; or, should you prefer more top flat for wiping, make it 2¼in.: this will give you only 3¾in. splay. The wider the top is kept the better chance will you have to keep the solder up to the joint.

It often happens that you will be called upon to wipe over a wet piece of board, such as a patch in a cistern, sink, gutter, and the like. When this is the case turn up the lead, and lay brown or other paper over the place [see Fig. 158, and description]; of course, dry the place as well as you can first.

Preparing and Putting the Lead into a Cistern.

Having the lead cut out, you proceed to roll it out upon the nearest floor to the cistern, or if in a roof, lay some scaffold or other boards upon the joist or otherwise, so as to form a stage; in fact, arrange this as best as you can, but look out that you do not damage the ceiling. Say, everything is ready: the cistern Fig. 315 is to be lined. First, see if the sides are parallel, then take the depth of the side, and the thickness of the board for the turn-over lead at C, and lay this upon the lead at E F, and also at D A, Fig. 319 (let these marks be made with a chalk line, and parallel with the top edge of the lead); next, see if the bottom is parallel also, take the exact size of it, and line this upon the lead, taking care to allow ⅜in. for the substance of the lead, so that it may be easily put in, as shown from A to L, and F I; now mark off the top of the other side, as at J K, and strike a chalk line. Next, see if the cistern is square; if so, lay a square or templet upon the outside line of the lead, as at E D, and square the lead G H; then measure the end H I, allowing sufficient for the top-edge turn-over, and strike the chalk line I F; *but be sure to have it at the same angle as the cistern, which is in this case square.* Next, measure the bottom from I to L, allowing for the thickness of the lead, &c., as before mentioned—namely, ⅜in. Now see that this line is square to A F, and strike the line A L; then measure off the distance from the bottom line L to the line M, and strike the line M N, leaving the 1¼in. for turning over the top edge, as at T V. I must now refer you to the lines O P Q R, outside the main or dotted lines H G M N, &c. These lines are, with the

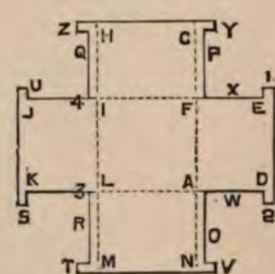


FIG. 319.

compasses, struck ¾in. to 1in. away from the main or chief lines, and are for the return lead; that is to say, to turn round and nail to the side of the cistern, as shown at G, Fig. 320; the small pieces, S U Z, Y V, and T, Fig. 319, are for covering over the top of the corners of the cistern [see C E, Fig. 322,] which must be sunk down for the solder to be wiped flush. Having marked this lead out, take a good pair of snips (10in. or 12in. long is the best size for our work), and cut the lines Y P, V O, T R, Z Q, and 1 X, as also 2 W, S 3, U 4; the latter four lines *are cut within ½in. of the meeting-point of the lines* at A F I L. Having cut the lines as shown, next procure a piece of quartering—let it be straight, and with good edges—lay it upon the line G N, and pull up the side E D, and, with the hornbeam dresser, set it in; but not too sharp. For cistern-work I often knock it from behind, and up to the quartering,

which tends to thicken the lead at the line. Next place the quartering on the line M H, and pull up the other side K J; set this in as before; next provide yourself with

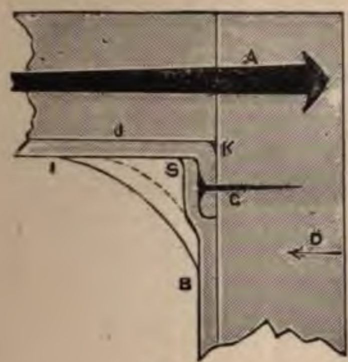


FIG. 320.

a piece of quartering the length of the bottom of the cistern less the thickness of the lead, and lay this upon the line I F; pull up the end H G, and set it in; next lay the quartering upon the line L A, and pull up the end M N, and set it in; now the sides of the lead are all pulled up square. Next bend the return lead R O P Q to clip sides as shown at Q L P F, Fig. 321. The next thing to do is to knock

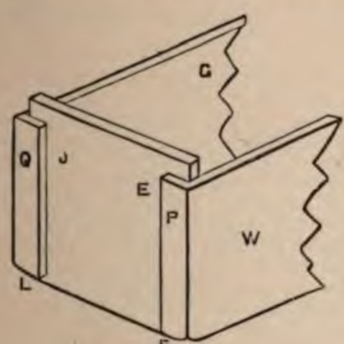


FIG. 321.

the corners L F, Fig. 321, into a slightly-rounded shape, so that the sharp corners of the lead will not catch or hang in the angles of the cistern when the lead is being put into it. See that the lead round the bottom is square; then, with the dresser, bulge or belly the bottom of the lead inwardly, say 2in. or 3in. up; this will draw the sides inwards, and so make the lead narrower. [For a further description of this, see my next volume on Roof Work, &c.] Now have what holes you require cut in the bottom of the cistern, especially the waste, which must be dished down, as shown at Z, Fig. 326, to allow of the lead-pipe, also the washer, being wiped flush, or little below the bottom of the cistern; have this hole cut large enough to allow for the opening of the pipe to receive the washer. This is a point very often not allowed for, being generally cut too small, as are also butler's pantry-sinks. Have the top corners sunk down, say, 2in. wide, and $\frac{3}{4}$in. deep, so that the solder may be wiped flush, as shown at C E, Fig. 322, and F, Fig. 577.

Now examine the cistern for nails, glue-teats, &c., also clean it out; then drop the lead carefully into the cistern. Pull the lead J E, Fig. 321, inward, and with the dresser or chase-wedge drive the lead P Q, Fig. 322, to fit closely

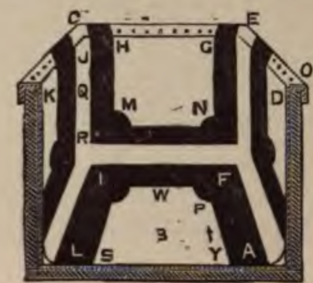


FIG. 322.

into the angle, and nail it every 6in. or 8in., as shown at G K, Fig. 320. Next knock down the top lead over the top, as shown at K D, Fig. 322, and nail it with $1\frac{1}{2}$in. copper nails every 3in. apart. When copper nails are not allowed, use $1\frac{1}{2}$in. Town clout (iron). Some plumbers turn the lead right over the outside of the top, as shown in the above engraving. I beg to give you a word of advice respecting the wedging in of your lead into the angles; do not knock it so as to knock the sides or ends of the cistern apart, and after your lead is fixed just notice whether the sides are all right at the angles. Important.

Now, we come to the soiling and shaving; but before we do this, I will describe another method of lining cisterns. Suppose it is required to line a cistern in three pieces—that is, the side and end in one piece, and the bottom dropped in.

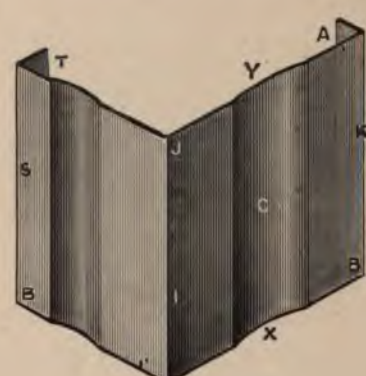


FIG. 323.

Proceed as follows:—Having the right sizes, line the lead and set it up, and boss up the angle I, Fig. 324, as also illustrated at T S B, J I, K B, Figs. 323 and 325. T is the return lead for nailing, as is also A; turn the lead to stand 1in. or so on the bottom, as illustrated at E F U, Fig. 324. Having attended to the little requirements (see that no nails are standing through the wood-work, &c., &c.), now place your knee against the side and bulge it in as at C, Figs. 323 and 325: this will shorten the lead between J K, Fig. 323, and will allow it to go easily into its place. Next place this in, as you did the first piece, and nail it there; see that it fits properly. Now fix the other side and end, but

do not use any nails in the overcloak of the lead up the angles, but fix the lead by driving it home with a chase wedge, having its point ¼in. or so thick across the face, or to finish with a ⅛in. narrower will do; well drive it home, but do not split your lead or drive the

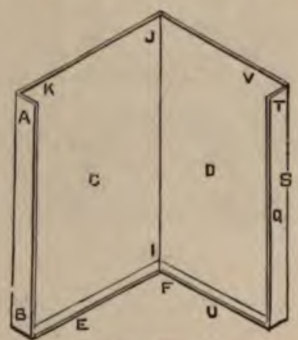


FIG. 324.

side of the cistern out as before mentioned. To prevent this, the cistern should always be made as illustrated. The next thing to do is to prepare the bottom, which is done as follows:—Having measured round the bottom and allowed for the substance of the lead sides, mark out the exact size of the bottom, less ⅜in. for the thickness of the turn-up lead; then with the chalk line line out the lead; never scratch it with a scriber. Now kneel upon the quartering, and with the point of the chipping knife passed under the edge of the lead, answering as a lever, pull it up against the quartering, and with the end of the dresser knock the lead well up to the quartering, and so get it thickened in the angle and

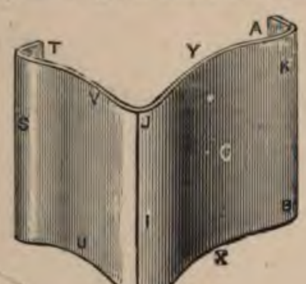


FIG. 325.

to stand up square to the bottom. Having done this all round the lead, next boss up the four corners; then bulge it in the middle. This will shorten it each way, and will allow it to drop easily into the bottom. You can now put it into its best position, and, with a piece of board laid upon the lead, jump upon it, and so cause the bulged part to go flat upon the bottom of the cistern, and the lead to expand, and the edges will jamb themselves against the sides, &c. Now take a dresser and hammer, and set it in all round, after which take a chase wedge, and drive the lead well home, causing it to wedge itself, as shown at S, Fig. 320, tightly to the sides and ends.

Burnt-up Joints.

For preparing the cisterns ready for burning the joints, see Fig. 96, and description, also zinc cisterns, Figs 337 and 336.

Soiling Cisterns.

Take the compasses, set 5in. or 6in. open, and from the angles scribe all round the sides and bottom of the cistern as shown at H M G N S Y, &c., Fig. 322, and with the same radius and from the outside points of the soiling line to strike the quadrant J N, &c., as shown; this is most useful, for the bottom especially, when wiping upright corners, as it keeps the solder off from the naked lead, and also gives a sort of finish to the work. Next soil the parts within the marks, and dry it with shavings, hot irons,

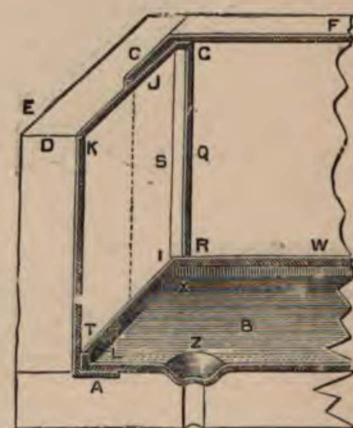


FIG. 326.

or as best you can; or, if time will allow, let it dry gradually. Next is the cutting off of the return edge or selvidge Q, Fig. 326; here you require a good straight-edged *sharp* chipping-knife [see Fig. 33]. Assuming it to be properly worked home with the sharp chase wedge, take the chipping-knife and small cistern hammer [see Fig. 48], beginning at the top near J, and cut off the selvidge edge within one-eighth of an inch, or less, of the angle; cut this straight, and from top to bottom; also round the bottom; then take the *sharp* chase wedge, and a good-sized hammer, and well drive the ⅛in. of lead into the angle, which will wedge itself as tight as is required [see S, Fig. 320]. *Do not use nails in the overcloak lead, where it is to be soldered.* Some plumbers do no not touch it with the chase, wedge after cutting off the selvidge with the chipping-knife, but I like to set it in as shown at S, Fig. 320.

Shaving.

This is of more importance than many suppose. You cannot be too particular. In the first place, you require a small, sharp, shave-hook, the blade to be no larger than

CISTERN SHAVE HOOKS.—FIG. 327.

will shave the exact width you require the solder to be when finished. For my part, I like the shape of the blade

to be nearly the same as that illustrated at S Q G, Fig. 327. This is about *half* the right size; from Q to S should be ¾in. This will shave about 1¼in. wide. Some plumbers use a triangular cistern hook, similar to that shown at A B D, Fig. 327. The circles F and E show the stem of the hook. When using these hooks, see that they are well sharpened, for a dull shave-hook makes dull work. The shave-hook being all right, and in proper order, proceed to apply the part Q into the angle of the cistern, and with the point S gauge the shaving line, by holding the back part of the hook firmly to the angle of the lead, and with a good long stroke or sweep draw the hook down, and so shave to the desired width. If too wide, the hook, of course, must be made narrower.

Proceed with this, and thoroughly shave the edge of the OVERCLOAK *lead*, so *that the solder will well hold it to the undercloak* ; also be sure to thoroughly clean out the bottom corners with a *round-nosed* spoon hook [Fig. 51]. Touch it over as you go on shaving, and all will be now ready for soldering. Some plumbers, after they have shaved their work, get a punch similar to a carpenter's nail punch, and so punch the cut off edge of the lead into the back lead all up the angle; this holds it in position when not properly chase-wedged up. Never use a straight-edge for shaving a cistern. Such work is only done by those who are not proficient in their trade.

Soldering Cisterns.

For a cistern the size of that described at Fig. 315—namely, about 1ft. 6in. deep and 2ft. square, one large iron will do the work, and a pot of solder, say, 10lb. For large cisterns more irons will be required. I have watched my own working, and find that a large iron will comfortably

FIG. 328.

do from 6ft. to 10ft. of flat wiping, and from 3ft. to 7ft. of upright wiping. I have done 9ft. of upright work with one iron, and often have done cistern wiping without an iron or its equivalent, which, if much practised, will be found as easy to do as an underhanded joint.

I may here state that I was challenged to do this by one writing in a trade journal *(The Plumber and Decorator)*, and on the 9th of March, 1883, I accepted through the same journal the challenge for the sum of fifty pounds to do in public six feet of upright angle wiping without an iron or its equivalent, but simply with the ladle, splash stick, cloth, and ordinary plumber's solder, but the challenger, who thought it impossible, backed out after my money was deposited; nevertheless I did the wiping in the presence of about twenty plumbers and other persons interested in the matter, and other equally good work was done at the same time, such as 4in. and 6in. underhanded joints, some 6in. and 9in. breakcorners, &c. Witnessed by A. O. Brien, J. Willis, H. Jones, T. Heywood, plumbers.

Speaking of the quantity of solder used for large cisterns, it will be found much the best method to reckon enough solder: ½lb. to the foot. This allows for getting up the heat, &c., though for small ones 6oz. will be ample, unless the water acts upon the tin in the solder or the workman is greedy; in such cases, 1lb. to 2lb. will be required. Having your solder-irons hot, and everything right, with warm cloth, splash-stick, &c., ready, take a piece of board B, Fig. 328, and lay it, as shown, in the bottom to catch the solder, and to prevent it getting on the shaved part, S and W, of the bottom. Next take another piece of board about 1in. thick, cut to fit the outer angle, as shown at A B, Fig. 328, and, with two nails driven into the ends and into the sides of the cistern, fix it, as shown. This will catch the metal while the top part of the joint is being made (this bit is often more bother, and takes more time than wiping a foot or two of the angle work), or, if the cistern runs against the wall, push some paper, &c., between, so as to prevent waste of solder. Everything is now ready. Give the mate orders to "bring it" (the metal) and a piece of board, or, if the cistern is in a close place, a piece of lead or iron to stand the metal-pot on. Take the ladle full of solder in the left hand, and with the splash-stick in the right, commence splashing the metal on at the top and down to J, then to Q and R, Fig. 328. Keep at this, occasionally with the splash-stick picking and pushing up the metal from off the board B, until you can feel it work lively, or like so much soft putty. Keep rubbing the splash-stick into the solder to test it, and keep picking the solder up to the work, at the same time splashing on more metal, until it is in a soft state. When it is in this state, and having plenty of solder on to retain the heat for a few seconds, *quickly* put the ladle into the metal-pot, let the mate hand the iron from the tail end, or by his catching hold of the turned part of the handle, with felt on it, into your left hand, and let him give the warm cloth. [For the size of the cloths, &c., see Cloth Table.] Now, with the ball of the iron just touch over the top and down to about J, that is, 3in. to 6in. down, and with the cloth wipe the top smooth, as shown, and down to about J; hold the cloth between the fingers, and wipe down to Q; now, with the ball of the iron warm up the other solder from R to Q, and when it is in almost a running state apply the cloth from where you left off, and wipe gradually down with a long, steady sweep, say 9in. to 12in. at a time. Do not attempt to wipe if the metal will not move, for it will be too cold, and if you should move it, most likely the joint, or the metal, will be broken, and perhaps too fine to be perceived; it will leak, and you will not be able to find out at what part. When splashing on your solder, you will find the lead to rise and come up from the wood work. This must be pressed down with the cloth when wiping, viz., press the lead down say about an inch or so on the soiling. Having wiped the angle down to about R before the metal has time to set, push the nose of the iron into the solder at Z, and with the cloth clear the surplus metal away from the joint; then remove the board B, Fig. 328, and, by so doing, you should bring all the overplus metal with it, leaving the joint clean at the bottom, and to appear as that at J Q R, Fig. 329. After this is cold, take a strip of brown paper 3in. by 3in., well soaked in water, and well paste it over, and fix it over the bottom part of the solder at R, so that the solder will show only about ¼in. up the joint, and all is ready for soldering the bottom. To the

unskilled it will be best to wipe these upright angles flat on their side—that is, when the cistern can be moved about. Having all the upright joints wiped out, and the paper pasted round the bottom part, as at R—or, instead of pasted paper, some plumbers, especially those proficient, use chalk over this part, to prevent the solder adhering (I have seen it soiled over after being chalked, but this is a dirty job), next call for the metal, and begin splashing from I towards P, Fig. 316 (this being right-handed for wiping). When you have about two small ladles full of solder on the joint, warm it up with a large iron, and with the right hand wipe about 9in., keeping the iron close to the solder, and again warm up and wipe another 9in., and again warm up, still warming up and bringing forward the cold metal and wiping away until more metal is required to be splashed on. Keep at this until nearly the whole of your metal is gone, or cold; or, better, until the ends of the joints meet; or, if a two-handed job, until both plumbers meet. Wipe the corners out clean by applying a gradual heat round the outside and cold parts. It should appear as that shown at R, Fig. 322, and quite clean. If there should be a joint in the middle of the cistern, as at Q F, Fig. 316, this must be wiped before going round the bottom. In finishing off well warm up the cold meeting-part of the metal, and do not attempt to wipe it too cold, or it will appear scratched and rough. Nothing appears so bad as a slovenly finish, and tells a long tale about the workman. Sometimes the overplus metal will be in the way, especially when finishing; then clear it away with the cloth or shave-hook, &c., and see that it does not tin the lead, so as to stick fast where you do not want it.

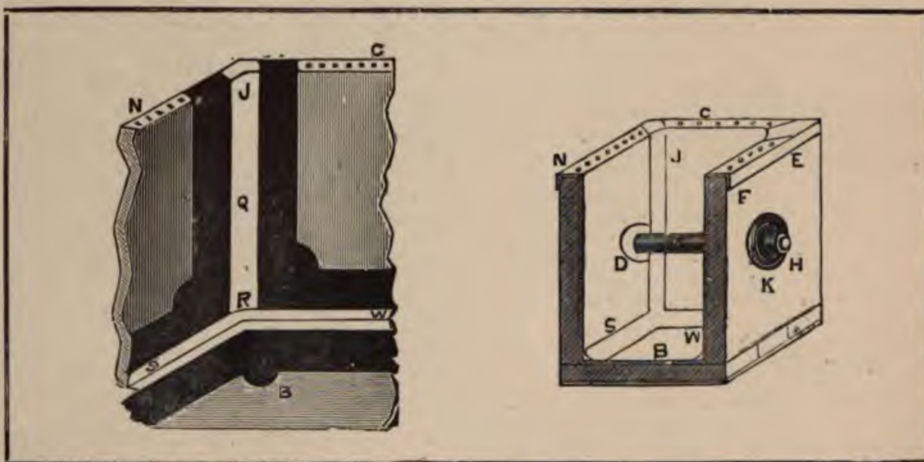


FIG. 329.

Wiping Cisterns Out without Irons or their Equivalents.

There are many degrees in plumbers' work, which you cannot expect to learn all at once. Wiping out cisterns well marks the progress made by the young workman. After you have learnt to *properly* wipe out a cistern with the use of irons, you should try and do without them. The following is the best method to proceed. For upright work, have your ladle bent in front to near about the shape of the angle of the cistern, then with splash stick and cloth in the right hand commence splashing on about 18 inches of solder, keeping the top the hottest part. Get it to a good lively heat, and quickly draw your cloth 12 inches or so down the joint; warm up the bottom end with fresh solder, and splash on another 18 inches, not forgetting the keeping alive of your place where you left off wiping. You will find no difficulty in doing this after a month or two's practice.

Stays to Cisterns.

Large cisterns—such as 10ft. by 3ft. and 3ft. deep; or, say, one 7ft. deep by 3ft. wide and 7ft. long—should have stays across the width, and oftentimes across the ends. These stays are nothing more than iron rods passed through lead pipes, as shown at D in the right hand cut, Fig. 329, and screwed up with nuts from the outside, as illustrated at K H in the above diagram. When fixing the lead pipes for such rods, let the ends of the pipes just enter the holes of the wood sides, and not to butt against the side, otherwise it will be a troublesome job to get the iron bolt through the woodwork. The ends of the lead pipe should be soldered as at D. Do not wipe the lead to the side when the rod is passed through; it cools the metal too much.

Overflow Waste Pipes.

[*Also see Trumpet Mouthed Wastes.*]

These pipes are often put in without due consideration; often too small and at other times *too large*. In many cases a 1in. pipe will answer much better than a 2in. pipe, unless properly arranged so that a draught may be created by the running water itself; and often two inches or three inches of the useful effect in the depth of a cistern is lost, which in large tanks is of no small consideration. For an illustration

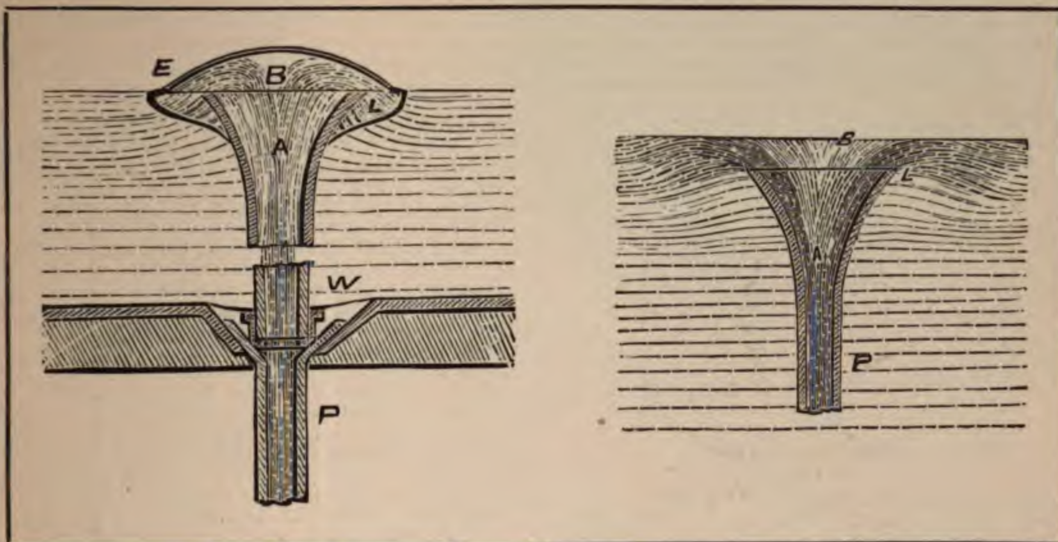


FIG. 330.

of this refer to Fig. 330. Here the water is seen to rise over the lip of the pipe as at L, similar to a weir whose length is equal to the circumference of the lip of the waste pipe, and before the pipe can become full bore, the water must rise from three inches to six inches above, owing to the induced current, or what I now call the *vena contacta*, which tends, so to speak, to create a partial vacuum at the centre of the pipe at B. This is due to the different rates of motion caused by the difference of the weight of the water within the pipe, and that at the lip, and may be reasoned out as follows:—The water at its starting point moves slowly, and increases its velocity, or accelerates itself according to the law of gravitation. The bad effect produced by the *vena contacta* may be prevented by keeping the air away from the centre of the mouth of the waste pipe, which may be done by simply covering the top of the waste pipe, as illustrated at E B, and leaving sufficient water passage between its lip and covering as shown in the same figure.

Battened Cisterns.

I have already referred to the ancient cisterns, and now propose to give a few lines upon the old battened lead cisterns. Let me, therefore, refer you to Fig. 331. This is a

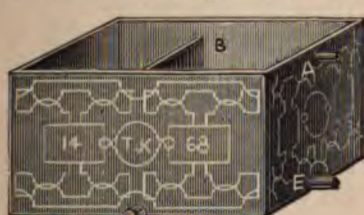


FIG. 331

drawing of a good lead cistern, now 416 years old, and in a perfect state of preservation. The size is 3ft. 2in. long, 2ft. 6in. wide, and 2ft. deep; the bottom, sides, and ends are ⅛in. thick, with strengthening work as shown in front. On the two front squares is to be seen the date, and on the circle the initials of the maker. Two of the upright corners are wiped up, as also the bottom. All round the joint is rough, but the solder is at least ¾in. thick, and untouched by the action of the water. This cistern was formerly used for rain-water, but latterly for street supply water. Fig. 332 is another old batten cistern, but of circular shape. This bears the date 1552; it is therefore 332 years old, and

FIG. 332.

in as good condition as on the day it was made. This shape tells a tale that even in those days plumbers knew the strongest form and manner of construction.

Modern Battened Cisterns.

Fig. 333 is a modern battened cistern, made by myself in the year 1880, for holding sulphuric acid. The sides and ends are strengthened with raised ornamental work; the substance is ½in. thick, the angles are all solidly burnt up, and it is about 3ft. square and deep, with a lead top, but not soldered. Its weight is 14cwt. 3qrs. 24lb. Fig. 334 illustrates a large battened cistern, cast and made by myself in the year 1881, and which bears my initials, and date, as at P, J, D, K (for Kensington) and 1, 8, 8, 1. The

design, as also Fig. 333, is my own. The ornament gives great strength to the sides; but notwithstanding this I have 18in. plates, 3ft. by ½in. thick, soldered to the sides at B, and from E to F, and the ends from G to H, to keep them in their proper shape. This cistern was made for a

FIG. 333.

vault, where it is impossible to be got at, except just at the front. It is supplied by a 1in. 12lb. to the yard pipe passing through the front at R, and from a small feed cistern fixed some distance away, and level with the top of large cistern. The top of the cistern is covered with a 1¼in. slate slab, and the brickwork is arched over close to the slab. K is the outlet pipe. The reason for fixing the

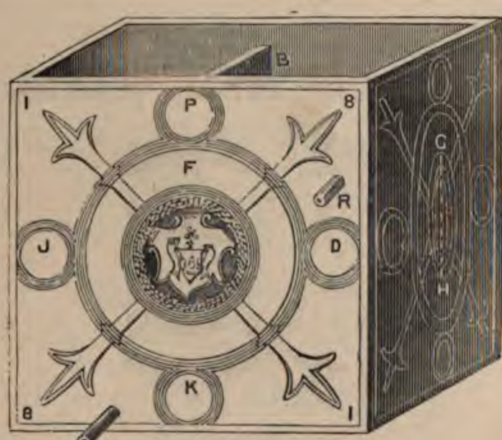


FIG. 334.

inlet pipe at R is to allow the water to fall into the cistern with force, in order that it will wash itself out when the pipe K is open. Should the pipes burst with the frost (which is not very likely) or otherwise, the pipes can be repaired or newly fixed. This cistern, if left alone, will be intact a thousand years hence.

Casting Battened Cisterns.

For the method of casting these cisterns, refer to the sheet-lead casting. Having the pattern of the front or sides, &c., prepare the sand; but let the bed be much thicker than is required for sheets, in order to allow for the ornamental parts. Say the pattern is 3ft. square; lay it face downwards upon the sand, and well beat it down all over, and perfectly level. This must be done with great care, in order to get the print true and sharp without an uneven surface. After this two persons must lift the print with the four handles provided for that purpose—the handles are fixed at the four corners—then proceed to cast as though it were sheet lead, leaving the proper distance between the sand and the strike for the substance of the lead.

The best method of casting the ornamental fronts of batten cisterns is as follows:—Take the pattern (say it is 3ft. square with ½in. fillets nailed all round the outside of the pattern, and on the face side)—let it be smooth at the back—lay it flat upon the table, face upwards, as at A 5, Fig. 12. Now sift the sand in sufficient quantity to stand ½in. above the face of the pattern, level the sand with the strike to the level of the fillets, then tread or otherwise beat the sand hard and smooth on what is now the surface; next take what is known as a backboard—this is the same size as the back of the pattern, but this backboard must have a quantity of, say, ½in. steam holes, as in the bed of the frame—lay this board flat upon the levelled sand, and keep it firmly pressed upon the sand; now lift the pattern, sand, and backboard all together, taking care not to shift the backboard or sand from the pattern. Now, the sand is between the two boards, turn the backboard to lie flat upon the bed of the frame, and carefully lift up the pattern, when you will have a good print from the face of the pattern; and if care has been taken in preparing the pattern with proper fillets suitable to the substance of the lead, you need not again touch the sand, more than just the making up the edges suitable for the lead to flow from the head-pan into the mould, and the surplus from there into the foot-pan. Prepare the strike to suit the substance of the lead required. Tip or cast the lead a little colder than is required for sheets, and as thoroughly explained in sheet-lead casting.

Iron Tanks or Cisterns.

These cisterns are made to any shape and size, and are well illustrated at CISTERN and TANK. Fig. 335, which

FIG. 335.

shows two of Braby's cisterns. They are rivetted round the corners. This firm also supplies them galvanised, and

they are of the very best make, of which more will be said in my Hot Water Work. [See next volume.]

Zinc Cisterns.

In the country these cisterns are often lined by the plumber, and therefore I shall give my readers an insight how to proceed with this work. First cut your metal in such a manner that the soldering is always away from the angles. Now examine Fig. 336. Suppose the sheet, C D E F, there shown to be the size of the end or side of a

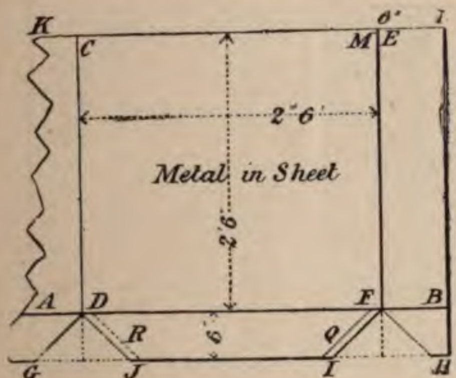


FIG. 336.

square cistern; call it 2ft. 6in. long, and 2ft. 6in. deep. First strike the bottom line, A B, then measure off 6in., as from E to L, or K to C; this return edge is to allow the zinc to be soldered up without being soldered in the angle, and, as shown at F A E, Fig. 96, draw the line, E F; now measure the end or side of the cistern and measure the metal, as at C E, F D, Fig. 336; then take the bevel set to an angle of 45 deg. and lay it upon the bottom line, A F,

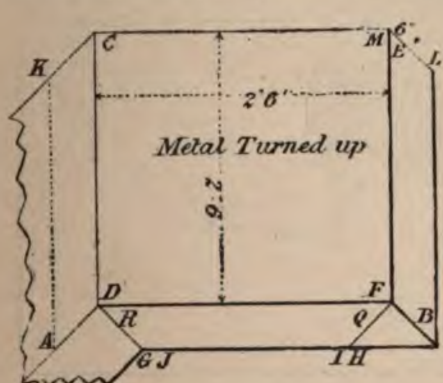


FIG. 337.

and with a pencil mark the lines, B H, F I, D J, A G, and with the snips cut the scollop pieces out, J G A, and I H F; but leave about 1in., as at R Q, to form a kind of underlap when the zinc is bent round. Of course, if the cistern is not square the piece, H I F, &c., must be cut out accordingly, which you easily tell by practice. Now get a piece of quartering, say 4in. by 3in., and lay it on the line, D F; then pull up the bottom, G I J H, square to the quartering, and with a zinc worker's mallet (viz., a boxwood mallet with a flat head) knock the zinc square up to the quartering; next lay the quartering on the line, F M, and bend the side, or return zinc, L B, up to the quartering as before. Serve the other side likewise, and the end or side of the cistern is ready to put in. (Should you require an inch or so to turn over the top, as at K, Fig. 322, allow for this when measuring the depth; it is usually done.) The zinc is now bent to the shape shown at Fig. 337, also shown at Fig. 324. Now measure all your cistern, and line it as directed. When all is marked, cut, and bent up, put it in, and with a few zinc or other nails nail it; put the bottom in so as to be able to solder it, say from 3in. to 6in. from the angle; knock the corners, as at F and D, so that they are a little rounded and so that they will not catch in the angle or sides when you are sliding or dropping the metal into the cistern.

Soldering a Zinc Cistern.

Suppose your cistern to be a fixed one, and to be lined as at Fig. 96. First solder up the upright seam, A F, which is done as follows: With a spirit brush put some raw spirits of salts all up the joint intended to be soldered. Have your copper bit nice and clean, with a pointed nose and with a face all round; now have a stick of good fine solder and begin at the bottom, at F, Fig. 96; first put the solder against the seam, and with a bit bite a bead of solder off, which will still hang to the nose of the bit, and transfer it to the zinc, then another bit of solder and transfer it just above the last bit, and so on, bit by bit, until you get to the top, doing about ½in. to ¼in. at a time until you can do larger pieces. Of course, you should bite the bit of solder off the stick when the stick solder is held up to or against the seam. The secret of this soldering work lies in being able to transfer the solder from the stick to the zinc in such a manner that it will appear like that shown at F A, Fig. 96, which will soon be acquired by patience and practice. After you have run up your upright seam, do the bottom, which will easily be understood after what I have written on soil pipe soldering, &c. Always solder your work strong, and be sure to see that every bit of your joint is properly tinned and covered with solder. Always wipe the joint with rag and water after the soldering is done; this is to take off all traces of the spirits of salts. This class of soldering is partially done by capillary action.

Filters.

Before I leave the important subject of cisterns, it may be prudent to explain something about filter cisterns and filters, as they in some cases form the cistern itself. For this refer to Fig. 338, which illustrates four different views of filters, although all working on one principle. The section B contains and illustrates the silicated block through which the water percolates into the second chamber, wherein is fixed the SECOND MEDIUM, or layer of filtering materials. A illustrates the ELEVATION OF CISTERN FILTER, and shows the draw off tap; and C shows that the filter may be of any ornamental design, as also an ornament in a place. D illustrates the filter made self-supplying and fixed below the cistern, also connected with a supply pipe INLET to the filter; also with OUTLET draw-off pipe leading to draw-off tap; the draw-off pipes should be made of tin.

Sometimes the filters are fixed inside the cistern—in fact, the filter, B, could be so arranged, but there are various kinds of filters in the market. Whatever filter is used, the filter, like all other things, can only do a certain amount of work, and when this is done it becomes a useless article, which may be briefly explained as follows: Whatever may be the filtering media, this only acts to remove the mechanical impurities from the passing water, which may be done by allowing the water to pass through a cistern having a perforated division about two-thirds down, supporting, first, a layer of *clean washed* sand, say 6in. to 9in. in thickness, and placed on the top of some fine shingle about the size of horse beans, or from ¼in. to ½in. in diameter; then some more ½in. to 1in. in diameter; or instead of sand, preferably a layer of charcoal and powdered calcareous stone. As the water passes through the sand, so are its mechanical impurities, such as insoluble salts, carbonates, nitrites, nitrates, and organic matters arrested, and held in the top bed or layer of sand, and after this has been going on for a certain time, the top sand for an inch or so down becomes clogged and dirty, which must be taken up and rewashed, according to the state of the water.

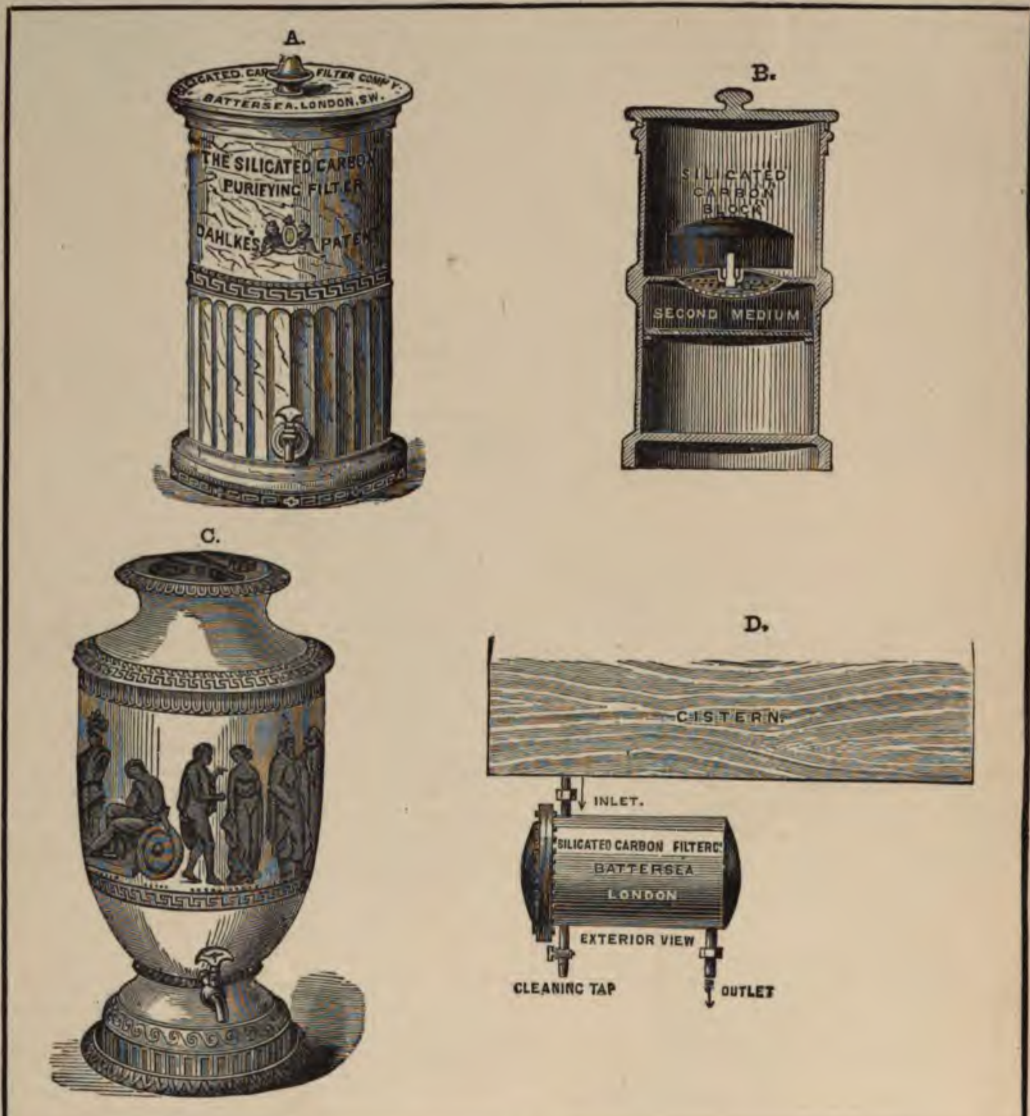


FIG. 338.

I may add that you can contrive your filter by placing a

perforated double partition in a cistern, and filling it with the washed sand. Several of such partitions may be arranged in one cistern. Say that Fig. 316 is the cistern. Place a double partition at J P E, 9in. wide, perforated with ½in. holes; place some canvas or fine wire gauze against the holes; now fill the compartment quite full with washed sand; here the water will pass from H G part of the cistern to K. Say that the water is not quite cleaned, then put another compartment of sand at B, and so on until your water is properly cleaned.

A good filter bed which is continuous will yield in twenty-four hours from 70 to 100 gallons of filtered water to the square foot of its area, dependent upon the thickness of the layer of sand, the state thereof, and the depth or pressure of water above the sand.

Of course when *soluble* chemicals are held in water this filtering cannot be expected to remove such impurities, and in order to remove these chemical reaction is necessary in order that soluble chemical may be thrown down either into its metallic state, or into an *insoluble* salt known as precipitation, when it may be filtered. Or these soluble chemicals may be removed from the water by distillation. For instance, all our fresh rain water is derived by a vast process of distillation and again condensed and deposited on the surface of the land for our use; some of it percolates the bowels of the earth, when it ultimately passes, in the form of spring water, from strata to strata, and by so doing it mixes with the stones, ores, salts, and gases; and by this continual accession it again becomes impregnated with the composition of this earth's solid crust, which is composed of about sixty-three known elements, to say nothing about the elements not known. What may we expect when we know that water is the most solvent of all chemical substances. Gases dissolve in water in quantities varying with the nature of the gas, and in accordance with the temperature and pressure to which the gas is subjected. (This accounts for the water in stink traps becoming fouled and stinking during the absence of fresh water.)

Sanitary Plumbing Job Complete.

Now we are speaking on the subject of cisterns, and to give my reader some idea of what a complete house of inside plumbing is like, I cannot do better than refer him to the diagrams 339 and 340, which fully illustrate the cisterns on the top of the house, the sinks top and bottom, baths, closets, lavatory basins, drainage ventilating pipes, and water supply generally, all of which form one complete masterpiece of plumbing. It should be understood that, although I have given these two diagrams simply as a preparatory view of the work, I shall nevertheless fully refer to them hereafter in my "Sanitary Plumbing Work," and shall give full details and working drawings. These two diagrams are views taken from a job wholly executed by the hands of the author, and will be understood from the following brief description.

At the bottom on the right hand corner of Fig. 340 may be seen one of Buchan's traps, known as the MAIN TRAP leading to the sewer; the top part of this trap is open, to be covered with a grating through which the SINK WASTE pipe discharges. Sometimes the trap is called the intercepter trap, sewer gas excluder, &c., but by whatever name it may be known, it is nevertheless only a trap of good construction, and answers every purpose. It is made by Messrs. Craig & Co. Now the trap is fixed, proceed to examine the drain, which is generally made of common drain pipes having their joints made thoroughly sound with Portland cement (and which will be fully treated of in my work on House Drainage); but in this case as shown at PUMP BARREL, LEAD DRAIN, Fig. 340. The drain, is composed of some excellent 4in. pump barrel (which was supplied by John Bolding & Sons), in order to secure perfect safety through the house. This drain, as may be seen, is continued up the wall of the house, and terminating above the roof as at 27, thus answering the purposes of a soil pipe and ventilating pipe, having the closets and housemaid's sinks branched in as shown. The action is as follows: Of course should a slop pail full of water be dashed down the housemaid's closet, as at 16, Fig. 339, it goes quickly away through the Ɒ-trap 18 into the branch H S W *(housemaid's sinks wastes)* into the soil pipe, through the drain and into the main trap. You will observe that at 18 is fixed a non-siphoning Ɒ-trap, and a smaller Ɒ-trap under one of Jennings' celebrated closets, as at TRAP, Fig. 340.

The above diagram, Fig. 340, illustrates the plumbing work in the basement of a house, showing the soil-pipe S, brought down with a bend at the bottom, and in this case continued under the house.

In the left hand corner and at the bottom of the soil-pipes, Fig. 340, is fixed one of Sharpe's patent flush rim closet basins and trap, a closet basin which I have fixed hundreds of, and which I always have held to be perfect in its flushing, inasmuch as the water passes round the rim at its upper edge, and is constructed so that the stream from the said rim concentrates itself to a centre, thus giving friction and thereby keeping itself, when a proper supply of water is used, thoroughly sweet and clean. [For further elucidation of servants' closets, see Fixing Hoppers and Basins, Balloon Basins, Basement Hoppers and Closets, &c.]

Servants' Closets, Position of, &c.

Though my writings are supposed, and, *de facto*, are intended, to instruct plumbers as to the best method of fixing any kind of work that may fall in their way, I must beg to be excused if occasionally I depart from the absolutely practical path, and endeavour to show, from moral reasons, why this, that, or the other is necessary and requisite. The question of servants' closets is more important than *primâ facie* it may appear—viz: There are many servants who, whether male or female, are particularly delicate in visiting a closet if seen by the opposite sex. This is by many persons of a more obtuse temperament considered "false delicacy," and, possibly, in this respect they may be right to some extent, as of course the requirements of nature are common to us all; nevertheless, that this delicacy does exist, at least in *England*, is beyond any argument, and as the want of closet convenience is mainly the cause of the discrepancies in the action of the liver, and consequent indigestion, biliousness, congestion, &c., I have thought it politic to preface my instructions on this most important point with the reasons why they should be strictly attended to.

In large houses, where servants of both sexes are employed, it is usual to fix the closets for males and females in the basement, and where practicable, the better method is to place the closets for one sex in the front and the other sex at the rear of the house. The advantage in this arrangement does not consist only in the sanitary advantage already alluded to; but it also tends to the prevention of unseemly familiarity amongst servants that would otherwise exist. I am, of course, conscious that it will sometimes happen that on account of the construction of a house it is not possible to follow my instructions by placing male closets at one side of the house, and the female on the other side, but at any rate they should be so arranged that they are not both within the same range of sight.

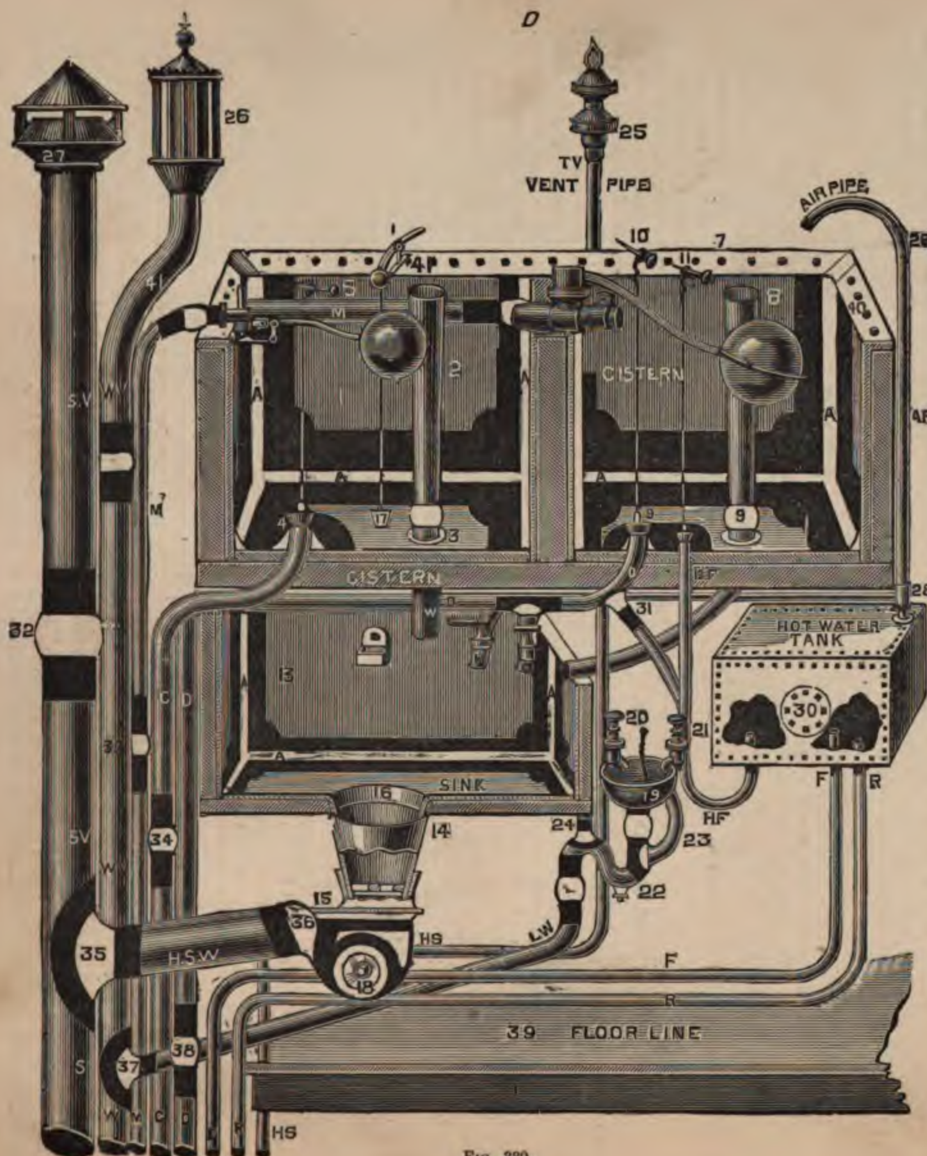


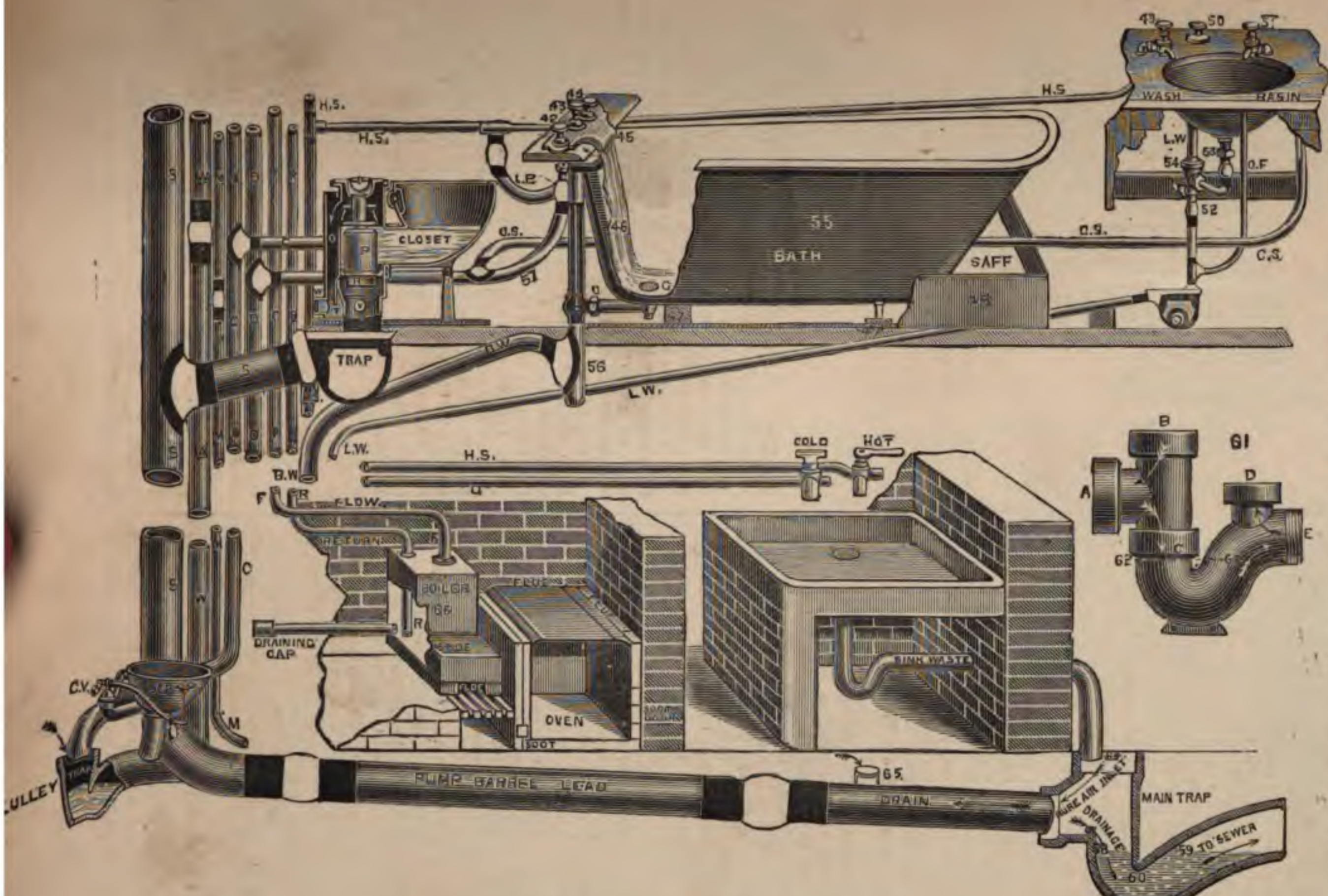
Fig. 339.

Ventilation of Soil Pipes, Drains, Traps, &c.

Now, the sanitary job being so arranged, let us examine it for the point of ventilation, the whole secret of which is in a nutshell. First cover up the top part of the m ain trap. The top of the soil-pipe is open at 27; this of course gives the gases a chance to get out of the soil-pipe, but it now stands to all intents and purposes like a bottle filled full of smoke.

Experiments in Ventilation.

For illustrating this get a long-necked wine bottle and with a long pipe and tobacco, place the mouth end of the pipe into the bottle and blow it full of smoke, You will find the smoke remain there for a long time, but knock a hole into the lower part of the bottle (which may be done with a small pointed punch, and the hole may be covered with putty, &c.), and the smoke will, in proportion to the size of hole, gradually disappear, either upwards or downwards according to the degree of temperature of the bottle. If the bottle be cold, the smoke will become denser than the external atmosphere, and the consequence is that the smoke will by gravitation fall, and so make its exit at the lower aperture; but if the temperature of the bottle be raised to above the temperature of the external atmosphere, then the smoke becomes rarified and will make its exit at the higher aperture. But should the bottle and the smoke therein be of the same or exact density as the external atmosphere, then the smoke will remain stationary in the bottle, and may be blown out by blowing through the lower aperture, or by inserting a bit of compo tube through the neck of the bot..e, and carrying it to the bottom and blowing through. After you have tried these experiments, fill the bottle full of smoke again, having the piece of tube across the lip of the bottle nearest to you, and blow through this tube in such a manner that the wind will just strike the farther lip, and notice the effect which this wind will have upon the air just about the neck of the bottle. You will find the wind will tend to draw up the smoke within the neck, but no further than the bottom of the neck, though the bottom part of the smoke will be considerably agitated. Now take your tube, which we will say is a bit of $\frac{3}{8}$in. compo, sufficiently long to reach to the bottom of the bottle and about four inches above the top of the bottle, and cut an elongated slot sufficiently long to roughly branch in, say, a piece of $\frac{1}{4}$in. pipe, and to an angle of, say, 45° or thereabouts, something like that shown at Fig. 143; then bore a $\frac{1}{8}$in. hole two or three inches from the bottom of the $\frac{3}{8}$in. tube, fill the bottle full of smoke and let the $\frac{3}{8}$in. or D part of the tube Fig. 143 go to the bottom of the bottle. Now blow through the $\frac{1}{4}$in. tube, and you will find the smoke from the internal part of the bottle ejected through the upper part of the $\frac{3}{8}$in. tube until the bottle is



SANITARY JOB COMPLETE.—*For Description see Page* 147.

FIG. 340.

emptied of its smoke. The smoke may be produced with strips of brown paper which have been dipped in vinegar and saltpetre.

In the case of branching the $\frac{1}{4}$in. tube into the $\frac{3}{8}$in., it will act better if you flatten the $\frac{1}{4}$in. tube to about $\frac{1}{8}$in., so that the part at D, Fig. 143, protudes into the middle of the $\frac{3}{8}$in. tube. You can fit this tube in at different angles, as it will not be necessary to solder the same. Having experimented so far, apply the end of your $\frac{3}{8}$in. tube an inch or two down into the neck of the bottle instead of going to the bottom, and if the bottle be colder than the external atmosphere, or under the same condition as when you had the tube at the bottom, you will find that you will not be able to empty the bottle with this ejector.

Having seen these few simple experiments with smoke, you will now be in a better position to understand the theory of drainage ventilation, which may be considered to work precisely in the manner explained; and having seen and experimentalized with it, let us proceed with our Sanitary Job Complete. We must turn to our diagrams 339 and 340. We have said that the top of the ventilation pipe is open, but the PURE AIR INLET at the MAIN TRAP was

covered up, so that the drain and ventilating pipe is in the same state as the bottle of smoke without a bottom opening, and, therefore, in order to get perfect ventilation, the PURE AIR INLET must be uncovered, which will give you foot ventilation; then your soil and ventilation pipe at once becomes an inverted siphon continually passing fresh air from the trap inlet through the whole line of drainage and discharges itself above the housetop, but care should be taken that it is carried 10ft. or 12ft. above the highest points of the roof, and also to see that the PURE AIR INLET is not fixed near to doors, windows, or ventilating gratings. If circumstances will not allow of the trap being open as shown, a pipe may be taken from this inlet to any convenient place, thus answering as a fresh air inlet. The reason for this is to provide against the current through the pipes getting reversed by dull atmospheres, or strong winds, which may be blowing from the soil pipe side of the house over the top of the roof, and towards the main trap, which tend to lighten the atmospheric pressure at the main trap point, and which would at once cause the siphon composed of the soil pipe and drain to become reversed; but if this inlet pipe before spoken of is carried some little distance away from the foundation of the house, the chances are that the current will never be reversed; a lighted match will, if held to the fresh air inlet, indicate the air direction. Sometimes the authorities of the district in which you are at work will compel you to fix a ventilating pipe on the sewer side of the main trap for the purpose of ventilating the sewer, which I thoroughly agree with. When such is the case, a trap as in the right-hand corner of Fig. 340, marked A B, 61, &c., may be used; the sewer ventilating pipe coming off at D, and the fresh air inlet at B, all of which are indicated by the arrows. Buchan's trap may be had with this air-pipe socket. [See SEWER VENT PIPE, Fig. 396.]

Within these last ten or twelve years, there has been a lot of fuss made about foot ventilation as being something quite new; but, for my part, I fail to see how anyone can imagine it to be new, considering the following facts, which are indisputable. First, we know that the old square brick trap can be traced back for at least fifty years, and that it has been in use during this time on *main drains*, and placed on the premises nearest the sewer. Secondly, we know that rain-water pipes have been carried to the tops of our houses, and that soil pipes have been branched into them; we also know that some houses have many such rain water pipes, some 40ft. to 50ft. above the other. For instance, the rain-water pipe of a lodge, stable, or other outhouse, will often not exceed 12ft. in height, whilst those of the main building will run 50ft. to 80ft. in height. Then, again, it is quite a common thing to find untrapped openings in the main drain. Now, I would ask what is there in these short rain-water pipes and other untrapped openings to prevent them from becoming fresh air inlets, and the main building rain water and soil pipes from becoming ventilating pipes? My answer is, that there is nothing to prevent them acting as complete ventilators, and equal to those of which so much fuss is now being made. Let it be understood that, although I write in this strain, I am fully aware that only a few of the best plumbers had a knowledge of proper ventilation, and would have every workman know the principles thoroughly, but I object to persons claiming that which is not theirs.

We have been speaking about the strong currents of wind reversing the action of the air siphon, as shown at the soil pipes and drains, Figs. 339 and 340, and have shown one method of remedying the same; but there is happily another method for getting over the difficulty, and that is by the use of cowls. For simplicity of illustration I refer you to Banner's cowl, the principle of which is very clearly depicted in Fig. 341. Suppose this cowl to be fixed upon one of the ventilating pipes, as at Fig. 339, its action will be readily understood. The top, A A, revolves upon a swivel, E, which always should present its mouth or widest part to the wind; now, should there be a strong current of wind blowing, as indicated by the arrows, the wind enters the mouth of the cowl, A', with force, where it rushes forward

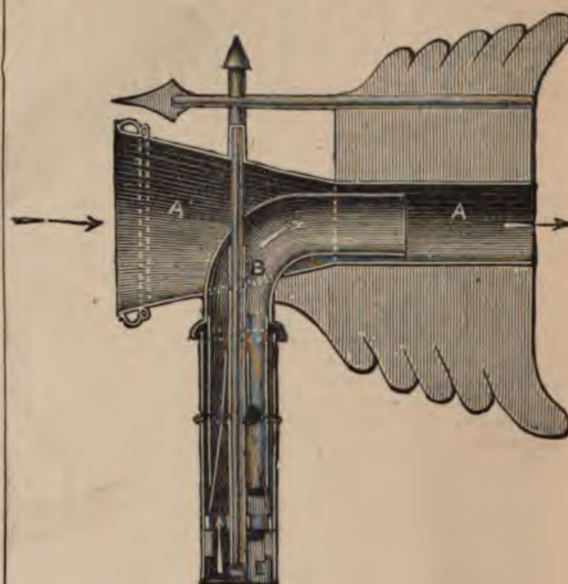


FIG. 341.

and becomes contracted at the mouth of the up pipe, B, where it again swells out, and by its accelerated force tends to create a partial vacuum at that point, where it in reality —so to speak—pumps the foul air out of the ventilating pipe, and so renders a down draft here an impossibility, which action is in principle the same as that shown in the tube experiment with the smoke. This style of ventilator can be made to fix vertically, which may be seen by reference to Fig. 342.

Many of my readers are familiar with cowls, and they have their favourites, though perhaps the very pet cowl which they consider best may be by others considered (and it often is so) one of the worst in the market; but, for my part, I shall not attempt to prejudice my reader's mind against any cowl which will answer its purpose, as we have had too much of this at the Kew cowl testing stratagems, and I take it as my duty to him to illustrate those which I consider well worthy of notice. I shall now refer him to one of the standard makers' immovable cowls, viz., Boyle's.

Boyle's Cowl.

The accompanying illustrations will almost explain themselves, but in order that the subject shall be thoroughly understood, and a clear conception formed of the principles of ventilation, I purpose dealing with the diagrams in their turn.

The system is illustrated by Fig. 343. It is known as Boyle's double action system of soil pipe ventilation, and consists of two pipes, 4in. in diameter, extending from the bottom to the top of the house [as shown in elevation, Fig.

343], one of the pipes forming the soil pipe in connection with the W.C.'s, and the other the ventilating pipe. They are connected at the top with a double action upcast and downcast ventilator pump cowl, and at the bottom with a bend, so that a complete circuit is established, the principle being to create an upward current in the upcast pipe, by means of the air pump ventilator A, the external air forcing its way through the downcast ventilator B, and down the soil pipe C; by this means a double power is obtained, and a continuous current maintained always in the one direction, owing to the force of the wind driven down the one pipe, and the suction of the air pump ventilator applied to the other, keeping the soil pipe thoroughly aerated and free from poisonous gases. The downcast ventilator is attached to and forms the bottom of the air pump ventilator, the plates or divisions of which being so arranged that an open mouth is presented to the wind (on the principle of the wind sail) from whatever quarter it may blow. D, upcast ventilating pipe; E, junction or bend, connecting upcast and downcast pipes [Fig. 344 illustrates a section of the system]; F F, inch and a-half pipes to ventilate the discharge pipes from the W.C.'s, and prevent the traps from being siphoned out by the passage of matter down the soil pipe, —of course this 1½in. pipe should not be branched into the soil pipe, but into the ventilating pipe; G is the drain trap; H is a 4in. pipe to ventilate the main drain on the sewer side of the trap, and which should be quite independent. This pipe is carried up above the eaves [as shown at the right-hand side in Fig. 343], and is surmounted by an air pump ventilator; the pipes may be fixed either inside or outside the house.

When it is added that this system has received the most

Fig. 342

Fig. 343.

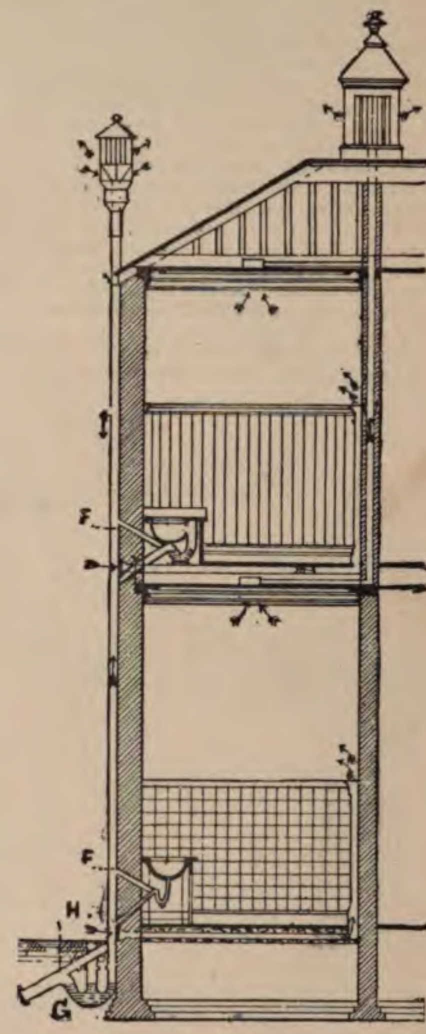


Fig. 344

unequivocal testimony at the hands of eminent authorities, my readers will be able to form some idea of its efficiency.

At this time, when the position, if not the existence, of plumbers is threatened by the evolution of a class of men calling themselves sanitary engineers, it is a matter of incalculable importance that the principles of sanitation, or hygiene, as it is also termed, should be thoroughly mastered, theoretically and practically, by those who, probably without knowing it, have been the pioneers in the sanitation of the past under the name of plumbers. And if they, through sheer inattention (by not putting themselves to the front), are content to lose the proud position they occupied, and, to a certain extent, still occupy, they will have only themselves to blame. I have taken this opportunity of explaining a branch, and a very important branch, of the subject, as implied by systems of ventilation. There may be many systems of ventilation, but the principle involved is in all cases alike, namely, the extinction, or, at least, modification of vapours inimical to health by the introduction of pure air. And it is impossible to deny that this is a legitimate field of study and contemplation to the young plumber, for it is to him that the public will ere long look for the preservation of health and the prevention of disease, for where there is prevention there will be no need for the doctor's cure.

You have seen Boyle's cowl fixed. I will now refer you to a larger diagram. Fig. 345 is a section which may be

Fig. 345.

Fig. 346.

fixed on the top of a soil pipe, and illustrates the proper angles which causes the wind to strike during its passage, and contracts itself so as to accelerate its speed at a given point, which by reason of the angles and the additional speed attained, and passing over an empty surface, having the cone-shaped or rounded enlargement or chamber, the passing and accelerated air induces the air in the larger surface towards the opening, precisely in the same manner as that which Hawksbee's showed in the year 1719.

Hawksbee's Experiments with Air.

He showed that when a current of air was sent through a small box the air within became rarified. No doubt many of you have seen the very instructive experiments, in addition to those which I have already explained, whereby a jet or spray of wind is made to play over the mouth of a cone-shaped tube, something like the nozzle of a bellows, which tube goes nearly to the bottom of a glass bottle, and when the lecturer applies the wind at nearly right angles to the top of the tube, light substances can be with ease pumped up, or even liquids may be raised in this manner. In fact, this system of making cowls is nothing more than taking advantage of the combined induced current of air discharging itself into, or over, the mouth of an expanded tube, whereby the high velocity of air is greatly reduced, and its momentum utilized and diminished by inducing air from the surrounding surfaces or openings. [See Banner's cowl, Fig. 341.] Siemen's jet exhauster is a contrivance of this description, and Gifford's injector is much about the same thing, excepting that steam is made to play upon water within a cone, the jet or nozzle pipe whereby the jet of steam issues, being placed in such a position as to limit the supply of water; but as I am not writing about Gifford's or Siemen's injectors, I will confine myself to the subject in question, namely, that of ventilation. I have already referred you to Fig. 345, Boyle's patent (section), now refer to Fig. 346, which is an elevation. Here you see the additional flattened cone fixed on the top for the wind to gather in, and the cone on the top to reflect the wind when blowing downwards. Now turn to Fig. 347.

Fig. 347.

Here is Boyle's principle again illustrated in another way, excepting in this case the feathers or wind gatherers [shown in the section and under the top cone, Fig. 345] are not employed, nor the wind guard on the top of Fig. 347, carried up to a point or cone, which in my opinion makes not the slightest difference so far as regards the action of the cowl. Now let us go a little further, and again take Fig. 346. For this argument cut off the top cowl and let the top opening be filled up; enlarge the top, which is now the middle plate, so as to cause it to protrude some inches over the centre, or in this case over the large edge part of the bottom cone. Let the cowl now float weathercock fashion with the wind, which in its turn will, on a windy day, blow like a forge bellows, and if this cowl is fixed over a down draft pipe or fresh air inlet of a drain having an up draft

shaft with or without a cowl, perfect ventilation or a free current of air must be maintained through the pipes.

FIG. 348.

This cowl, Fig. 348, is made by the Banner Sanitation Company, who have given ventilation and sanitation generally great attention for this last quarter of a century.

Double-action Cowl.

FIG. 349.

Fig. 349 is an enlarged view of Boyle's double-action cowl, illustrated on the left hand side of Fig. 343. You have seen Banner's and Boyle's cowls, but there is another maker yet whom I cannot pass unnoticed, namely, Mr.

FIG. 350.

FIG. 351.

Buchan. The cowl which I shall show in this volume is illustrated at Figs. 350 and 351. Fig. 350 is the one which he makes for soil pipe work, and Fig. 351, for roof work. This cowl is composed of a series of wind guards or vertical plates set in a perpendicular manner, with long vertical

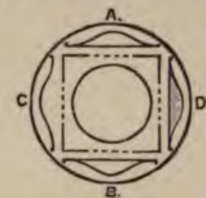


FIG. 352.

open spaces or slits between them to let wind pass and air out, and being placed as shown between the two cones, and at suitable angles, as shown in the plan [Fig. 352], causes the wind to reflect itself in such a manner that, in whichever direction the wind is blowing an induced current is certain to be produced. I should say that in the centre of this ventilator is a square tube or pipe perforated in the centre portion of each side, and with a single or double plate, or wind guard, opposite each perforated part of the centre tube, so that the induced current of foul air from the soil pipes passes through these small round holes or perforations, which perforations do not so readily allow down draft as they would were only long slits used. By the foregoing remarks you will see that at certain times it will be necessary to use some kind of effective cowl, and I consider that you should be now in a position to work perfect ventilation under any circumstances.

Before I can depart from my dissertation on ventilation, I wish to show my readers what implicit confidence some people put in this class of work; therefore I cannot do better than to at once introduce him to Banner's system, which is illustrated at Fig. 353; here is a diagram which at once brings my reader face to face with his system, which is as follows: First Mr. Banner does not like the idea of fixing a trap under the closet, and holds that it is a mistake to use hopper or balloon basins except in special positions. But whatever Mr. Banner's views may be about fixing a closet without a trap immediately below it, I certainly, for one, cannot cotton to his ideas, for I, as before remarked in this work, am thoroughly of opinion that no closet should be fixed without a properly constructed trap below it; and with all due deference to Mr. Banner, I say that no closet of whatever kind yet in the market can be considered safe without it (of course, save and except such closets as ship closets, which will be fully explained in another part of the work). But I must not depart without first giving the description of Mr. Banner's arrangements, therefore let us begin at the drain, Fig. 353. Here, just above the drain pipe, is an intercepter trap having a pure air inlet pipe; above this is fixed the soil pipe, which is carried up and having his cowl on the top. Here is at once the inverted siphon which you have seen at work in Figs. 339 and 340, but on this soil pipe, which forms this siphon, are fixed two branches leading from the closets, and not having traps under them. Let us see what Mr. Banner's ideas are in this matter. He maintains that the siphon will at all times be at work delivering fresh air through the whole line of piping, and that the closets, when the handle is pulled up, will also supply air to the cowl. Well, so far as this goes, at times Mr. Banner is right, and the system will at these times answer perfectly; but there is an exception to every rule, and I maintain that these exceptions will be proved by the following:

Let us assume that to-day is a cold, muggy day with heavy atmosphere; that the internal parts of the house are, as they should be, slightly warmer by reason of the windows and doors being kept moderately closed. At such times the air necessarily becomes heated, and rises towards

oof. Then air for supplying the fires, &c., will be making its way into the house through almost every possible ice or opening below the eaves of the house. Now, will suppose the pan closets to be constructed in the l manner with axles, &c., and that there is no trap w the closets. What is to prevent the air from below soil pipe getting into the container of the closet ugh where the axle, &c., works? Here it is quite

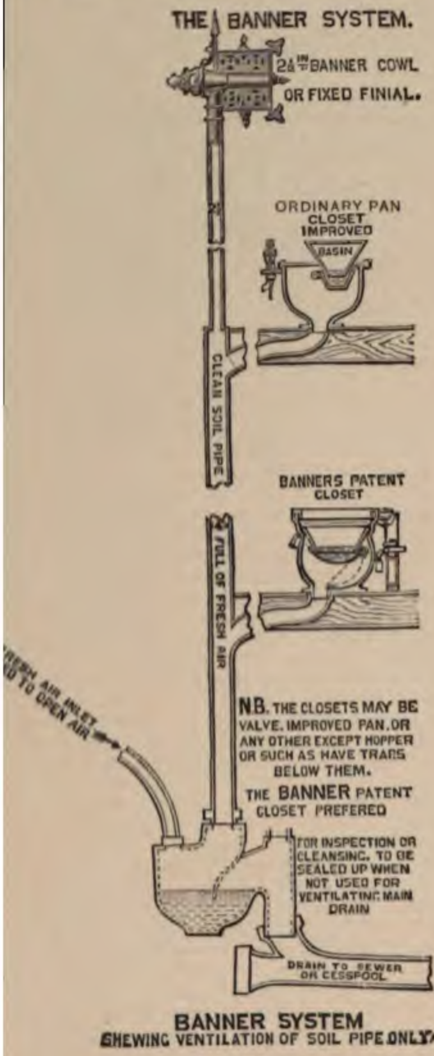


Fig. 353.

lent that it can pass; but suppose this to take place at period when the water is turned off for repairs, &c., the bowl of the basin to be empty, then how about air passing through the closets into the house? For urther account of Mr. Banner's principles, see copy of of his circulars at the end of this volume.

have in the former pages said sufficient to prime you the first steps towards perfect sanitary plumbing, which l be exhaustively treated of as we progress in practical plumbing, and which instructions are built on sound principles, from a period of at least thirty years' hard practical work, and which can only be mastered by studious working, which will be greatly facilitated by reference to my writings.

Before I commenced the subject of ventilation, we were working with the water supply, as shown at Figs. 339 and 340. Let us now examine the cisterns as they are fixed; here they are supplied with water from one of John Blake's Rams and through the main pipe M, and ball valves B M, Fig. 339. The ram has been working continually from three to four hours per day for these last five years, and continues to give as good a supply as the day it was fixed, and saves at least from 1*s.* 6*d.* to 2*s.* per day for pumping. I shall give a full description and illustration of these rams in my work on Pump and Ram Work. These cisterns have also standing wastes, 2, 3, and B 9, the ends of which should on no account be connected with a drain, soil pipe, or closet trap, nor in any other position where there is the least possibility of foul air passing through them; here in this figure the ends of the waste pipes discharge themselves over and into the housemaid's sink, from which there is no danger. The advantage of using these stand pipes is, as every practical plumber knows, that they act as an overflow or warning pipe, and also for the purpose of readily cleaning out the cistern. The cistern on the left is for the closet supply, which supply pipe is governed by either a *round way stop cock*, or a full way spindle valve, as at 4. The cistern on the right is for the purpose of supplying the dietic bath, and also the hot water tank; the outlet ends of the pipes being also governed by stop cocks or spindle valves. If you will trace these pipes, you will find that they supply the sinks, lavatory basins, baths, &c., which will be spoken of more fully hereafter.

Housemaids' Sinks.

Let us now revert to the housemaid's sink. This slop basin, which is one of Woodward's celebrated self-cleansing basins with flushing arrangements, is let into the pipe of the trap, and a better basin for slop sinks cannot be had.

Wash Basins.

Now let us examine the wash-basin, 19, and adjoining the housemaid's sink. Here we have the hot and cold water supply, as at 20 and 21, the hot supply, 20 being brought off the pipe, 31 and 28, whilst the cold is brought off the branch, 31. Here the basin is fixed over an ∞-trap, 22, the outlet of which is branched into the waste pipe, 37, and should not be branched into the soil pipe. This lavatory waste pipe is often carried through the wall to discharge into a head, as shown at L, Fig. 354. This lavatory basin, discharging into an ∞-trap, would, if the plug of the basin is of its proper size to supply the waste pipe full bore so as to keep it thoroughly clean, cause the ∞-trap to siphon out, and as a protection against this an air-pipe must be used, as shown at 24, and which is continued above the roof as at 25. 23 is the overflow from basin to the heel of the ∞-trap. Let us now examine the lavatory basin at the right-hand corner of Fig. 340, which is one of Twyford's basins, with Fell and Co.'s fittings, fixed on a wooden frame, the basin being let down level with the top boarding, and a marble slab placed on the top, which is with red lead bedded down upon the rim of the basin. The cocks are let through and screwed up from below, with back-nuts, the pipes being connected with unions. The waste pipe is governed with a standing waste, having a valve at the bottom, as at 54, or the overflow of this basin may

be a separate pipe, as at O F, but the waste pipe of this basin is made to discharge itself into a small D-trap, having a long length of waste pipe, as shown at L W (L W, lavatory waste). This long length of pipe is too far away to ventilate, and therefore a trap must be used which must be siphon proof; therefore work accordingly. A man who would use an S or V-shaped trap in such a position would simply be no better than a madman, or must have S and V-trap fever. I have said quite sufficient to prove to you that the D class of trap is the only reliable class of trap for this purpose. Of course the bottle trap is of the same construction as the D, therefore no comment is necessary. The end of this lavatory waste should be made to discharge in a similar manner to that before spoken of.

Baths.

This is one of John Fell and Co.'s baths, which, owing to its simplicity and durability, is fast coming into general use; it is fixed over the lead safe and on two blocks at 47, 47. When fixing baths care should be taken to fix them in such a position, that persons when using them cannot sit or stand in their own light, *i.e.*, the foot of the bath should always be fixed towards the rays of the light. Baths should also always be made to empty themselves as quickly as possible, viz.: with large gratings, suitable valves, and waste pipes with sufficient fall. N.B.—Air or overflow pipes should never be fixed into the waste pipe of a bath, as this prevents the water having the dragging effect which it otherwise would have when air is not admitted, thereby causing it to empty slowly. The overflows are best taken separately away, as at C, Fig. 354.

HOT WATER SUPPLY.

Now let us examine the arrangements of the hot water work. Suppose we begin at the hot water tank, Fig. 339.

Tank.

This tank is one of Braby's, a firm celebrated for the quality of their galvanized iron tanks and cisterns of every conceivable shape. During my foremanship with Mr. John Jay, nearly twenty years ago, I fitted a very large quantity of their galvanized iron tanks in the neighbourhood of Hornsey, and only a few weeks ago I was curious enough to examine them, and found them in nearly as good a condition as when I left them, whilst another maker's galvanized iron cisterns, fixed about the same date, and on the same estate, were as rusty on the inside as though they had never been galvanized, which proved that there must be a wonderful difference in the galvanizing. I also examined a hot water tank, fitted at Fairfield House, Hornsey, which I fitted in the year 1864. This was one of Braby's, and in a thorough good condition. The pipes were supplied by Russell's people (whom I have dealt with for many years) and the external parts were as bright as the day they were put up. I mention these few lines so that my readers may think first before they purchase, for half the battle is (in our work) buying of respectable firms when durability is required, for nine-tenths of the depôts for plumbers' goods are dear even though they may be given to you, and be assured, as I proceed with my writings, that I shall not scruple to recommend my readers to those firms which I have practically tested for quality, for at least these last twenty-five years, against those Cheap-Jack firms which I am sorry to say are by far too numerous in the United Kingdom, and which are the cause of many plumbers losing their employment daily, in some part or other. For instance, a plumber is asked to fix a valve closet without a lead safe. The basin round the neck is leaky, or the valve being roughly made will, when he is away from the job, hang up and overflow the basin; here the whole thing is out of order, and probably fetches down

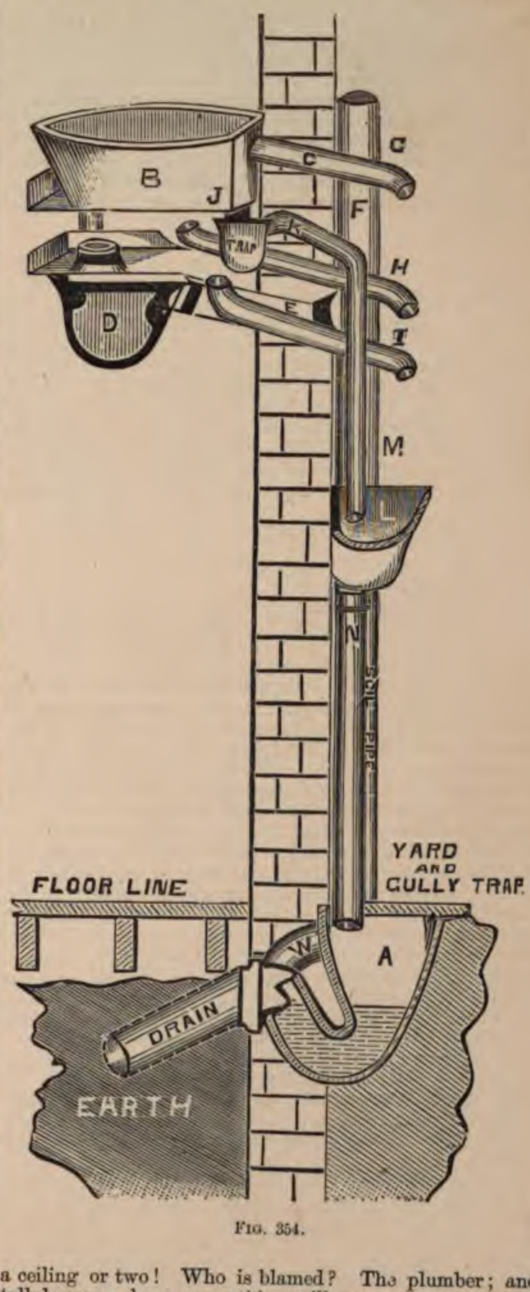


FIG. 354.

a ceiling or two! Who is blamed? The plumber; and, talk however he may, nothing will persuade some people but that it is his faulty work. Even simple screw-down stop-cocks are made without sufficient packing, and when the water is turned on a leakage is the consequence. They say the plumber is to blame, and of course the blame is

saddled on to him. Then again, to refer back to our cisterns, it is a common thing to have new iron cisterns run like a sieve; perhaps the work is contract to the plumber (labour only); he is expected to stop the leaka ge, often at no small expense. The same applies to iron piping; hence the reason why you should be as careful in judging your material as in doing the work; for what is worse than bad made pipe splitting at every thread you wish to screw, or, not at all unlikely, with a split in one of the awkwardest places about your work. I think I have said sufficient to induce you to seek respectable firms for the purchase of your material, more especially for your hot water work.

A good system of hot water work is shown at Figs. 339 and 340, but the working details will be given under the heading of Hot Water Fitting, &c., in next volume. The following brief description may give you an insight into the work:—

Hot Water Tank.

This has a piece cut away from the side or front, in order that you can see the method of fixing the end of the flow pipe, F, above the end of the return, R. The flow pipe, F, is the hot-water pipe coming from the top of the boiler. The return pipe, R, is the colder water passing from the hot water tank to the bottom of the boiler, as at R, where it mixes with the hot water and again ascends through the FLOW pipe in regular order. This is known as the close tank system, and no draw-off pipe should be fixed at any other place than off the top, as at 28, or preferably direct into the top. Sometimes this circulating tank is fixed near to the boiler, which allows the water in the tank to get hotter, it not having so far to travel through the pipes, but it is not advisable to place this tank in the kitchen, as in the summer months it makes this place too hot, unless properly protected with hair-felt, &c.

29 is the vent pipe, which must be well protected from frost, and taken above the water-line in cistern 7.

30 is the man-hole in the tank, to clean out or screw up the fittings. N.B. The air or vent pipe, 29, must never be taken the least below the top of the hot water tank, but be fixed to the top with a proper flange.

The pipes, F R and H F, are fixed with back nuts and grommets on the side of the stationary back nuts, because then the turning round of the nut does not cut the grommet away; another reason is that this joint can if *necessary* be tightened up from the outside without taking off the man-hole cover, but of course this should not be required to be done.

I have said that no draw-offs should be taken off at any other point than at 28, but in this, as in all other things, circumstances alter cases; for instance, suppose the hot water tank to be a matter of 100 feet away from the scullery sink, and no hot water pipe nearer; in this case I should take my draw-off from off the flow-pipe, and other similar cases may suit equally as well; but of course in this way you can empty the hot water tank when short of water, which must be guarded against during the times of frost, &c. [For a further elucidation, see Hot Water work next volume.]

PROPER HOUSE DRAINAGE.

I have now to call your particular attention to the matter of house drainage, for this important part of sanitary work should be thoroughly understood by the plumber professing a knowledge of sanitation, which knowledge every expert workman is now expected to possess, although I for my part say that earthenware drains, &c., are in reality works somewhat beside the mark of practical plumbing, equally so and as much as the architect is not the builder; therefore let us assume the present or coming *skilled* plumber to take the position of engineer in house drainage work generally, because at the present time our architects generally will not take the matter strenuously in hand; nor does the builder care to enforce the strict laws and rules of sanitation, so that between architect and builder, sanitation, if not taken up by the plumber (or some one else), who generally has the future control of such works, is utterly neglected. And hence the reason why I give you this subject in full detail.

It is not merely the digging of a trench and putting a few drain pipes together that constitutes a drain fit to convey the slops from sinks, closets, &c., though it cannot be disputed that the word "drain" signifies any kind of channel for carrying off liquids which may be open or closed in.

There is a wonderful distinction between a house drain and a land drain; and there is also a difference between a house drain and a sewer. Sewers are the receivers of house drains, therefore we shall not want to have anything to do with them, but leave this to the proper persons, such as Mr. Baldwin Latham, C.E., or Mr. Charles Slagg, C.E., who have made it their business to handle the level, and Mr. Box's, Mr. Beardmore's, Mr. Tredgold's, or other hydraulic tables. The construction of sewers is known to belong to the professional civil engineer, and any other person dabbling in this is almost sure to come to grief, as the non-experienced do with house drains.

To commence with, let us see what are the important features of proper house drains.

There are six very important points to always have in view—the fall, kind of pipe, size of drain, trapping, jointing, ventilation.

Fall for Drains

First, the fall, which should be sufficiently steep to cause the velocity of sewage to be, say, 4ft. per second, which allows the deposits to be pushed or urged forward through the drain without stopping at any point. But the following is my experience in London, which answers very well:—Give as much more fall as you like—1½in. to 2in., in 10-ft., for the main drain made of glazed pipes; 1½in., to 2in., in 5ft., for all branches; not less, but as much more as you can get, especially for the closet drains.

Some will say that you can have too much fall, but this is not my experience.

M. Dubuat gives the velocity per second necessary to remove solid substances in the following:—

	Ft.	In.	
Mud	0	3	per second
Common river sand	0	3¼	,,
Small gravel	0	4¼	,,
,, size of peas	0	7⅛	,,
,, size of beans	0	7¼	,,
Coarse ballast	2	0	,,
Angular shingle size of hen's eggs	3	3	,,

Prof. Rankin says that house drains should have a velocity of 4½ft. per second, and I quite concur with him, but you cannot always get it. Mr. Baldwin Latham,

C.E., says that "In order to prevent deposits in small sewers or drains, such as those of 6in. or 9in. diameter, a velocity of not less than 3ft. per second should be produced."

Drain Pipes.

Next are the pipes. These should be sufficiently large to carry off all the rain and other water and deposits, without being more than even half filled up. They should be as perfect in shape as possible, viz., round and straight There are different kinds of earthenware pipes; always select the smoothest inside, well glazed. These pipes are generally made in 2ft. lengths, excluding the socket, which is usually as follows: For 2in. pipe, 1¼in. to 1½in. length of socket; from end to end of pipe 2ft. 1½in. long; for a 3in. pipe, socket 1½in. deep; for a 4in. pipe, 1¾in.; in 6in. pipes, 2in. sockets; in 9in. to 12in. pipes, 2¼in. But these lengths of sockets vary in depth. This is the length of some I have just measured: 2in. pipe had 1⅛in. socket, one 4in. pipe had a 2¼in. socket, whilst another, 4in., has only 1⅜in. socket, and the 6in. pipe has a 1¾in. socket. But this is, at any rate, near enough for ordinary work. The thickness of pipes also varies, but these are the general thicknesses:—2in. or 3in. pipe, ⅜in. thick; 4in. pipe, ½in. thick; 6in. pipe, ⅝in. thick; 9in. pipe, ¾in. thick; 12in. pipe, 1in. thick.

Weight of Drain Pipes.

Weight of the above pipes are, for pipes of the following diameter: 2in., 7 lbs.; 3in., 12 lbs.; 4in., 16 lbs.; 6in., 29 lbs.; 9in., 52 lbs.; 12in., 86 lbs.; 15in., 126 lbs.; and up to 2 cwt. each. Of course this is when the pipes are dry.

Size of Drain Pipes for House Work, &c.

The size of a drain pipe must be determined by the class of work it has to do, and the fall you can get. Suppose you have a 6in. drain pipe, say 60ft. in length, that you have a 4in. soil pipe emptying a latrine, holding say 400 gallons of water, this latrine is 30ft. high, or above the top of the drain; this drain also takes the water, &c., from all the bottom part of the house. What would be the effect if you pulled up the latrine plug? The effect would be that you would have a fountain at the nearest outlet to the bottom of the soil pipe. Or, instead of a latrine, you have a cistern having a 3in. or quick waste; this is not at all uncommon in houses where the drains have been properly considered. But there is another reason why the drains should be large enough.

Mr. Charles Slagg, C.E., says in his work: "A pipe 6in. internal diameter is sufficiently large for the drains of the largest house, and it is not too large for the smallest house." Perhaps he should have said 9in. for the largest house, because the largest house may be a little stretched to a mansion, palace, &c., as Burlington or Northumberland House. In such I should be very sorry to fix a 6in. pipe. Again, falls make a wide difference to the size of the pipe required. What I do is this:—From the smallest house to houses having 15 to 30 rooms (including every room in the house), 6in. pipes, if laid as per fall of drains; if this cannot be got, then I use a 9in. pipe. For houses having from 30 to 80 rooms, a 9in. pipe, if laid as before; if not, the next size, 12in. pipes.

Another reason for large pipes is that, from the carelessness (if you like to call it so) of persons throwing down floor cloths, matchboxes, and the like, these sometimes settle in the main drain and there bank up the other solid substances until the weight of the water rises behind, and in a body pushes the impediment forward. This often takes place a dozen times before it gets out of the pipes. Now if the pipe is 4in., it is ten to one at least that it stops against the side of the pipe joints, thus blocking them up altogether.

Records of Stoppages in Various Sized Drain Pipes.

I have at Hornsey, during the years 1870-71, unstopped the following drains:—On the Campsbourne Estate, one 4in. drain twenty-three different times—almost monthly; another 4in. in what is known as Campsbourne-terrace fourteen different times; and to each house in Campsbourne-terrace, High-street, at least a dozen times each, until the lot was taken up and re-laid with 6in. pipes.

This was for Mr. J. Bolding, the well-known lead and glass merchant, of South Molton-street. These are only one or two cases of 4in. pipe stoppages which I have had.

Then Mr. Baldwin Latham says in his eminent work (second edition) on "Sanitary Engineering," page 184, that at Croydon, between March 27, 1852, and November 28, 1853, a period of twenty months, sixty stoppages took place in 4in. sewers, thirty-four stoppages in 6in. sewers, one in 8in., one stoppage in 9in., one stoppage in 12in., one in the 15in., and two stoppages in the 18in. sewers. Then he goes on to say that Mr. Cox observed that the number of stoppages in the 4in. sewer would have probably been greater, but some of these very small sewers were taken up during the period and replaced by others of a larger size. All the stoppages in the 12in., 15in., and 18in. pipe-sewers occurred from the insufficiency of the strength of the pipes.

Discharge of a 6-inch Pipe.

A 6in. pipe, running half full, with a fall of 1 in 60, is equal to a velocity of about 250 feet per minute. This will discharge 24 cubic feet per minute, or 150 gallons.

FIG. 355.

Simple Test for Drain Pipe.

Gauge the sides of pipe with the callipers, Fig. 355, for irregularities, Stop up the socket end with any material, such as fixing it upon clay or cement, or tie some parchment or something round the socket end, and then fill it with hot water. If the pipe is porous, the water will show itself by oozing through on the outside. The weight of the pipes will also give you an idea whether they are good or bad. A good pipe cuts true if you go the right way to cut it. [See Cutting Pipes.]

External Percussive Action.

Drive two iron chisels into the joint of a brick wall and 6in. apart. Place the pipe on a piece of board close against the wall, and just under the iron chisels. Then take two scaffold boards or a 3in. deal, 12ft. long, and place them under the chisels and upon the centre of the 6in. pipe, the pipe answering as a fulcrum. If the pipe is all right it will stand the pressure; some will stand you on the top of this lever, but it is not necessary to do so. If you require the real crushing strain, load the lever until the pipe gives way, and calculate the weight by the length of the lever. A good plan to load the lever is with a pail at the end of the boards, the pail having a rope to prevent it falling when the pipe gives way. Gradually fill the pail with water until the pipe breaks, after which weigh the water, which gives the exact weight.

Internal Pressure of 6-inch Pipes.

Some of our drain-pipes will stand from 30lb. to 60lb. pressure to the square inch.; others not more than 7lb. This should be sufficient to show their variableness, and that they cannot be depended upon for working under pressure.

Measurement of Drain Pipes and Prices.

The size is taken internal measurement, and the length from the inside or shoulder of socket to end of spigot end. The general length is 2in. to 12in. bore, 2ft., and from 12in. to 21in. bore, 2ft. 6in. length, and from 21in. to 30in. bore, 2ft. 6in. or 3ft. lengths.

Sold in lengths at so much each or by the foot. When sold by the foot they run, about

2in.	3in.	4in.	6in.	9in.	12in.	15in.	18in. bore.
3½d.	4½d.	6d.	8d.	1s. 2d.	1s. 10d.	3s.	4s. pr. ft.

Setting about the Work.

First, you should ascertain what is the depth of the main sewer, or the lowest point you can get to. Next, see how much fall you can have from the outlet to the top end of the drain. If you have plenty, you can take the drain either in a straight bed-line by making a gradual slope from head to foot, or you can give the pipes a good fall, and "after dip" or dive down at or near to the side of the sewer. This latter plan saves expense in shifting the earthwork, and answers the purpose very well. Of course you know that the trench must be made wide enough for laying the pipes and for the men to work in, and also that the ground must be broken up or unbared wider at the top, in order to allow for the shoring or timbering up, and that some trenches may be dug "plumb," whilst others are dug at a "batter," according as the ground requires, and which will be thoroughly explained as we proceed with the work.

Having now the fall, lengths, sizes, &c., set to work and make sketches after the fashion of Fig. 356 and Fig. 357. Fig. 356 is a plan, and Fig. 357 an elevation. In order to do this, you require a scale of feet, which see at foot of elevation, Fig. 357. This equals from 0 to 30, so many feet, and the division at the end these feet divided. Now, suppose that you wished to measure off 23 feet. Take the dividers, place one leg on the mark "20" and extend the other to the fourth division past "10," which equals the 23ft. [See drawings.]

Now, suppose you require to know the size of the breakfast room. Take the dividers and measure the plan and

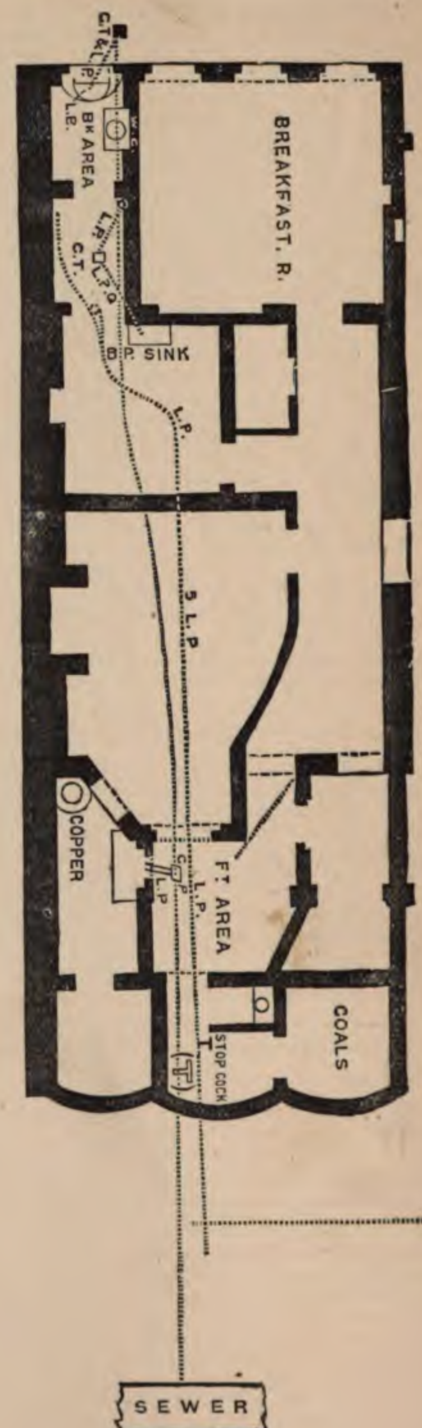


FIG. 356.

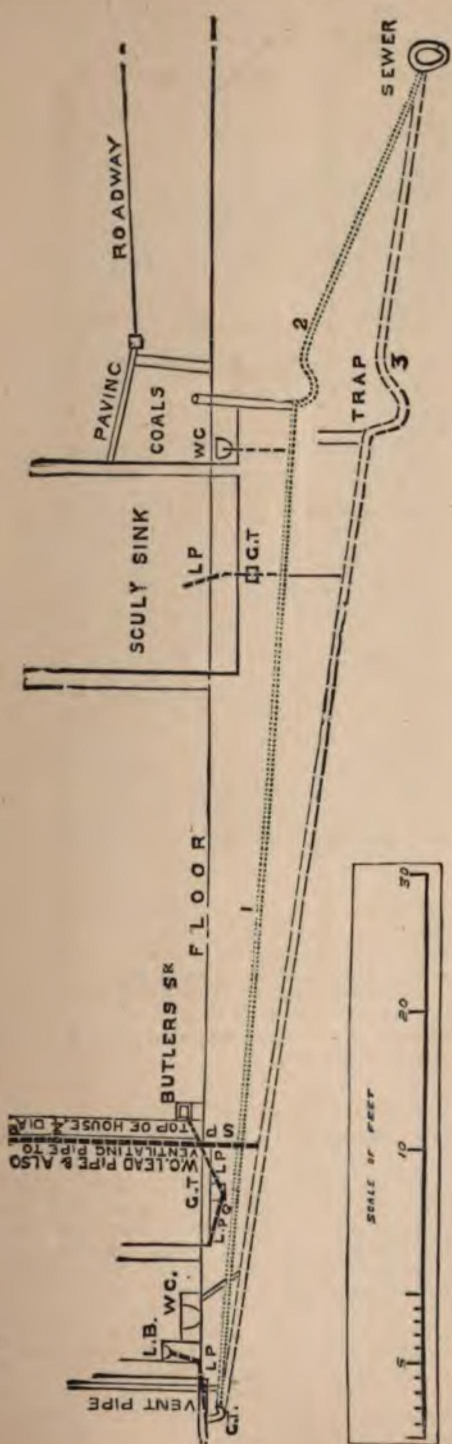


FIG. 357.

then apply them to the scales, and you find it to be 17ft. one way and 16 feet the other. This is called "reading" plans. In order to make them, you must measure the real objects and mark them out on paper with the scale of feet. You can make your scale of feet any size you like, but let it be properly divided into 10 feet divisions, and then one of these divisions into feet, as shown at 5, &c. The elevation is for indicating the fall, and all upright pipes, while the plan gives the same laid down. There should always be a plan of drains left with the vestry people of the parish (in Kensington they very properly enforce this rule), and also one placed in the landlord's hands for reference. At most places now about London you can get a plan of all new work from the vestry people, which is very handy at times.

Stone or other Marks.

G. T. means Gully Trap; L. P., lead pipe; B. P. S. T., Butler's Pantry Sink Trap; sometimes only P.T.; S. T., scullery trap; T., trap; S. C., stop cock; W. C. T., water closet trap; I. T., interception or main trap; M. T., main trap; C. P., cesspool; T., tank; W., well.

Drawings.

Drawings may be made with dotted lines for showing different pipes, such as the VENTILATING PIPE, Fig. 357; smaller dots for soil pipes, cross dots for rain water-pipes, red lines for hot water-pipes, and so forth. [Also see Setting about the Work.]

Shoring, or Timbering-up.

The trench being dug in different soils, &c., the sides require some protection to prevent their falling in. This is known in the trade as "shoring," or "timbering-up." Fig. 358 is the simplest method, suitable for good clay

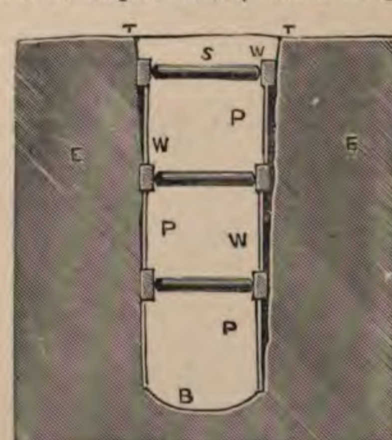


FIG. 358

earth. Suppose you are down 3ft., then set some short pieces of wood on end as at P—these are called "props." Next, take some 3in. by 7in. or 9in. deals, or two scaffold boards placed together if you have no deals, and place

these on their side so as to rest upon the ends of the props, as at W W, and well up against the walls of the trench—these are called "walings." After this, take a rod and measure the distance between these "walings," W W, and cut the "struts," S, a piece of quartering or scaffold pole, to this length. Just round off the ends a little and drive these struts between and lengthways with the waling, so as to jam the walings up to the earth. This fixes the walings. Now get the next in as quickly as you like,

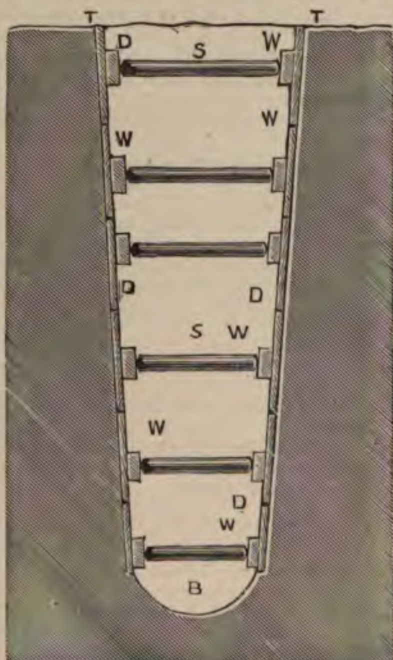


FIG. 359

until you are at the proper depth. Fig. 359 shows another and safer plan for the more loose ground. The difference is that a number of small boards, called "poling boards," about 2ft. 6in. long and 1½in. thick are used, preferably of hard wood, such as elm. These boards should be first placed behind the walings, and tightened up as before.

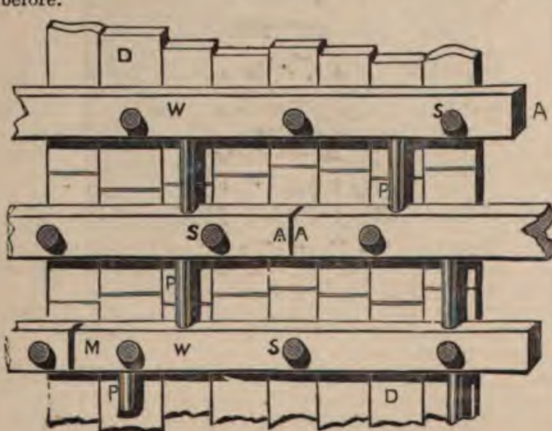


FIG. 360.

Fig. 360 shows a side view of the shoring done with poling boards; P, the props; D, the poling boards; W, the waling; S, the struts

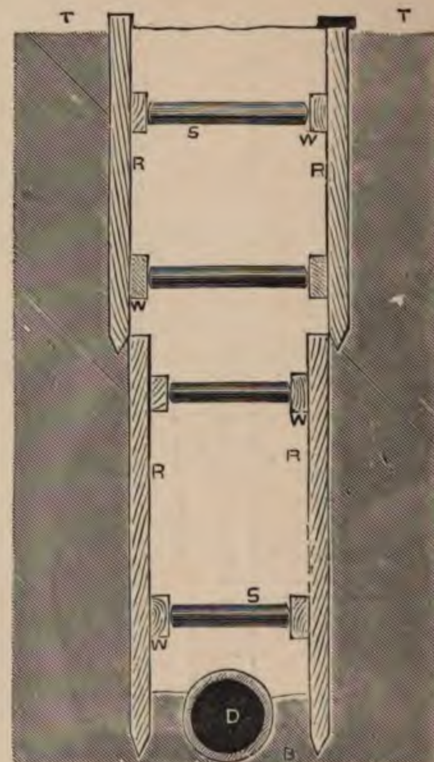


FIG. 361.

Fig. 361 represents a trench shored up with "runners," R R R, having the waling, W, and struts, S, as before. We use this kind of shoring for very bad ground.

When this kind of shoring has to be done you may expect bad bottoms, and it is necessary to lay wood or concrete for the pipes to lie upon. In very bad ground we use straw, twigs, ashes, &c., as a packing behind the poling boards or runners.

Artificial Bottoms or Foundations for Drains.

Now that we are upon the subject of bad ground, it will be necessary for me to explain the method of forming artificial bottoms. For this refer to Fig. 362. This is a trench cut through the top soil, clay, and into the sand. The bottom sand here is, say, quicksand, and as a matter of course will be very troublesome, unless proper precaution be taken to shore up, &c. In this trench I have used the runners, which must be driven down as the work proceeds. (In some quarters this work is known by the name of street piling.) The walings and struts are used as before. Here only one set of runners is used, but if two or more sets are used, the top must be excavated sufficiently wide to allow for as many sets as are required for the work.

In this class of work, when the bottom is very bad, it may be necessary to lay down a timber bottom of oak, elm, or

otherwise [see Timber on Sand, Fig. 362] for the concrete to lie upon. After you have the necessary thickness of

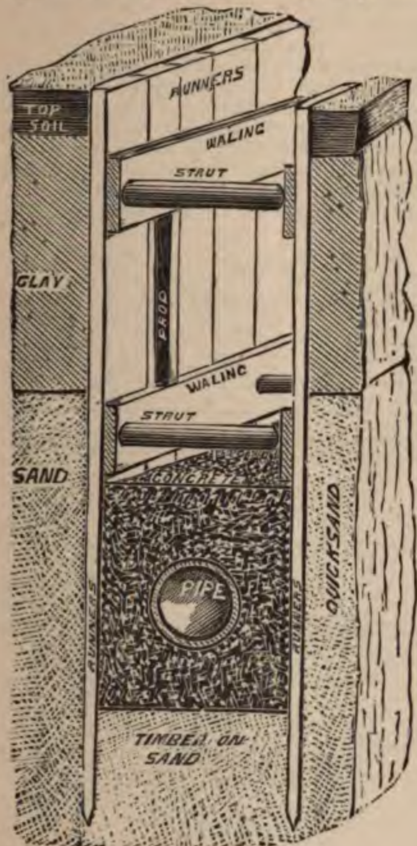


FIG. 362.

concrete, lay the pipe; then, if required, cover it as shown with concrete. Sometimes one 11in. plank will be sufficient

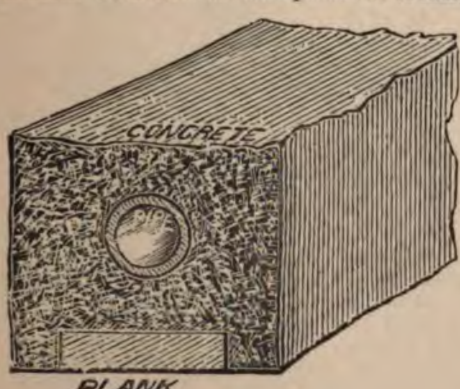


FIG. 363.

(see the end section PLANK, Fig. 363, and the longitudinal section, Fig. 364]. At other times it will be necessary for the artificial bottom to be made, as shown at Fig. 365. Here two 7in. by 8in. battens, or 9in. by 3in. deals, will

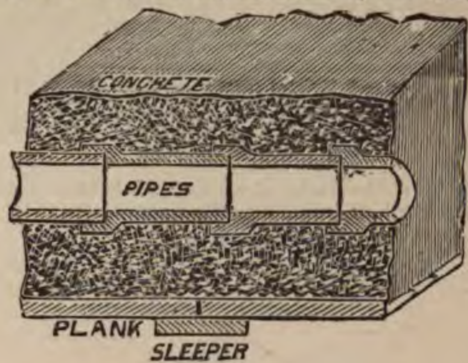


FIG. 364

answer, the ends of which should rest upon sleepers [see SLEEPER]. In very bad ground it may be necessary to

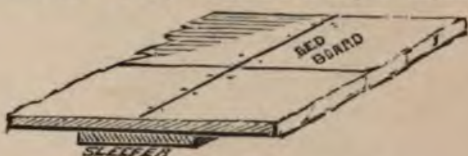


FIG. 365.

drive piling for the construction of the foundation. But this does not often happen.

Headings and Tunnels.

The method adopted for driving tunnels and headings

FIG. 366.

is shown at Fig 366. It consists in timbering the walls with poling boards, D, and supporting same with lintels, L; sills, K; frames, F; &c. There are two methods of cutting the sills for receiving the frames. The bottom plan at K K is for bad ground when it is likely to spew up; but in good ground we can dispense with the sill and let the bottom of the frame enter the earth about 6in. or 9in.

Concrete.

If the earthwork be of a loose or soft nature, a good bed of Portland cement concrete, at least 18in. wide, must be laid, or perhaps 2ft. wide would suit your work better, or, in other words, the concrete should be wide enough to stand out at least 6in. to 9in. each side of the sockets of the pipes. The depth of concrete should be in accordance with the nature of the ground; 9in. would be a good depth below the pipes. The strength of the concrete will vary according to the amount and quality of the cement used. For this class of concrete work, the stones should not exceed 1½in. in diameter. Three bushels of Portland cement (a bushel of cement is 1·28 cubic feet, and should weigh 110 pounds) will suffice for one yard of sand and shingle. In my drain work I often use 6 to 1, that is 6 of ballast (shingle and sand) and 1 of Portland cement; or, at other times, according to the work, I use 2½ bushels of clean, sharp sand to 1 bushel of Portland cement, and then 6½ bushels of clean gravel or shingle may be used. This is 2½ bushels of cement to one cubic yard of mixed concrete. Take care to lay the pipe *solid* in the concrete, and try all the joints before covering up. Should the pipes run under the house, lay 6in. of concrete over the top of the pipes, but not until the drain has been tested, which is done by stopping up the inlet to the trap and filling it with water, which should stand quite full at its highest point for at least three hours. [See Testing Drains, &c.] Having the trench open, and the eye ready for fixing, let it be fixed, as at E, F, Fig 367.

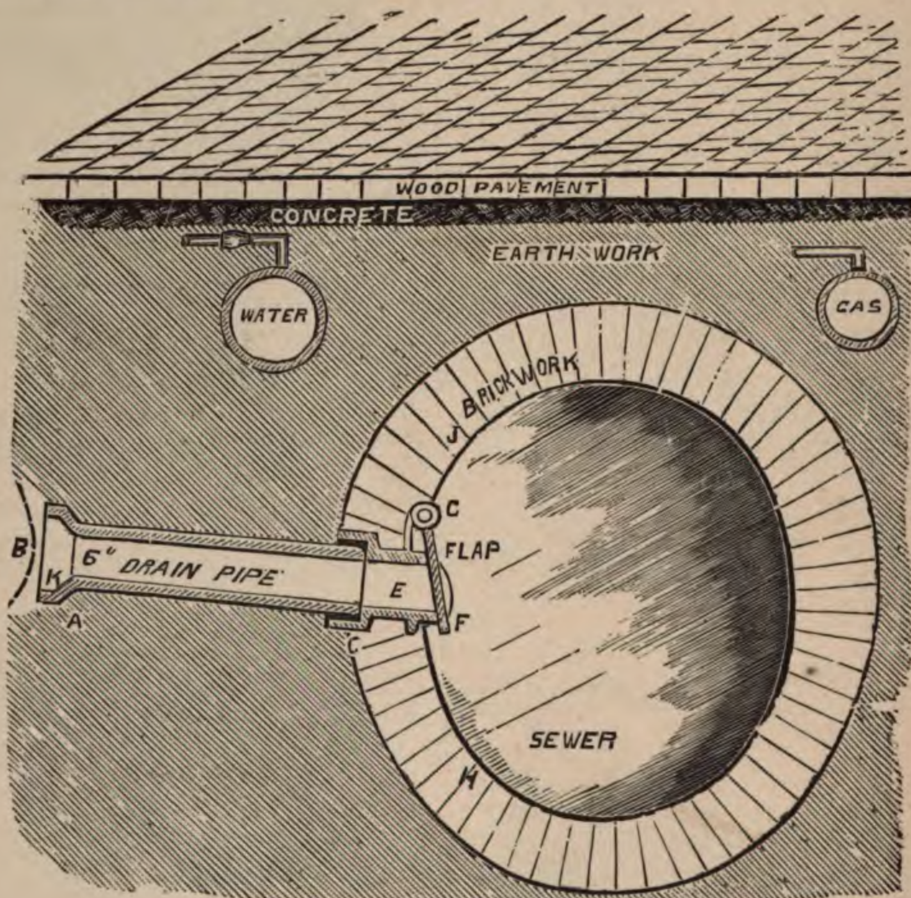


FIG. 367.

Here is a section of a brick sewer, earth-work, concrete, wood-paving, and flap (or, as it is sometimes termed, an eye), and one length of 6in. drain-pipe. This in Kensington is fixed by the vestry people, who also provide two lengths of pipe. Having the flap fixed next prepare for the fixing of the pipes up to the intercepter trap.

Having the trench dug, set to and lay the pipes. The first thing wanted is the sewer tapped, which is generally done by the vestry people or some one employed by the Board of Works. Before we proceed to lay pipes it will be as well to describe the method of cutting a pipe, which may be done as follows:

Cutting Pipes.

Having the exact length, mark the pipe true all round, then fill it (called "cramming") full of clay or damp earth, and ram it as firm as you can. Then with a good hammer and sharp point (a piece of steel brought to a chisel point), or good sharp chisel about 6in. long, made out of $\frac{3}{4}$in. or 1in. steel, set to work gently, and cut the mark all round; go round it equally, and from three to six times or more if required. Some people cut them standing upright, with the socket down, whilst others lay them flat upon their side. Many cut these pipes without cramming.

Cutting Short Pieces Off.

This is done by chipping the end with hammer and chisel; or I can break small pieces off true with hammers, one held inside, whilst with the other small pieces are broken off. If you have a good soft pipe (which kind should always be selected for the purpose of cutting) you can break the lot from end to socket without flawing or splitting it. You must do it steadily. This would be a good pipe.

Cutting Half the Socket off.

This is very simple if the pipes are fixed. Send your iron chisel as a wedge (but not up to the shoulder) under the inlet part of the socket without fear; you are sure to do this right. If the pipe is not fixed, then give it a clout upwards and on the inside of the socket; it will then break off close to the shoulder.

Taking up Pipes.

To take out a length of pipe, it is best to disturb two, or sometimes three, pipes, cut off the top of the socket [see "Cutting Half the Socket off"] and pull the others up. But, should the cement be too hard, then carefully cut out the other one or two pieces, then gently chip the cement out of the socket and also chip off the old collet part of the socket. Here such pipes as those described at Fig. 376 are very useful.

Valve Traps or Flaps.

[Figs. 368, 369, and 370.]

These flap-valves are made of earthenware, having iron flaps. Sometimes they are all iron, and are always to be had at Messrs. Doulton's. The use of the trap or flap is for

FIG. 368.

preventing the return of anything from the sewers into the drain, especially the rats. It is generally given to the vestry people, and they fix it into the side of the sewer for you to fix your first length of pipe to. Sometimes you will not require it.

Having the flap to fix before we can proceed further, let us see the best kind to use. I have given two of the regular kind; but there is another, known as Mr. Baldwin Latham's

FIG. 369.

balance valve [Fig. 370]. It is not at all uncommon to have to fix these valves above the centre part of the sewer. When the flap is so fixed and the pipe on the incline towards the surface, the old flap is dangling about with its mouth open gaping for everything, especially air. Mr. Latham has introduced an iron ball or weight which can

FIG. 370.

be adjusted to the exact balance of the flap, and this flap is well worthy of consideration.

Fixing Drain Pipes.

These are the next requisites. Fig. 371 is the ordinary drain pipe, to be jointed with clay or cement, either neat or one of sand and one of Portland, or

FIG. 371.

one of sand and two of Portland. Some people use Roman; it sets quicker. Lay the pipes on a good solid foundation, and let them be laid even and with the joints properly butting into each socket, as at Fig. 373, and, if possible, let the joints well set before they get any water through, disturbed, or filled in, but when filling in same use the finest soil or clay all round and over the top of same, well rammed down. Do not leave the joints unstopped or only stopped at the top, as at Fig. 372, which shows bad work. You see that the cement is put on the top and runs through and falls on the bottom, causing an obstruction in the bottom of the pipe, to say nothing about its leaking its contents into the earth, &c. Fancy such work as this in the vicinity of a well! and there are thousands of such, especially about small country towns and country mansions. All pipes and joints should be tested before the ground is filled in. *Important.*

Fixing Drains near Wells.

All drains within a hundred yards should be bedded in good concrete, and if close to the well in neat Portland cement at least 4in. or 5in. thick. If on bad or sandy ground) then first put a layer of concrete, and let it set, after which a good layer of Portland, shaped as near as possible to the form of the bottom of the pipe. After this is set, take the drain-pipes and bed them well into Portland, and in short lengths, taking care that no cement runs through the joint. Let this lot set. After this, cover the pipes with Portland cement, and then let this set before filling in the ground. This may be expensive, but quite necessary.

Lead Drains near Wells.

In some places it will be much cheaper to have good lead pipes run through the ordinary drain-pipes with proper wiped joints, as shown at Fig. 340.

Iron Drain Pipes near Wells.

The ordinary street water pipes may be used with advantage; but should be properly jointed with lead. Any junctions required can be obtained with the pipes.

Jointing Considered.

"What is the best kind of jointing?" will be a very natural question. That entirely depends upon circumstances. For temporary work—clay; but this is not to be depended upon. It is soft and yielding, and as the weight of the earth covering the pipe causes clay to be squeezed out from under the spigot or plain end of the pipe, it is clear that this pipe has sunk, and in doing so leaves an aperture in the upper part through which the gas may escape. But, it may be said, if the pipes are properly bedded, how can this be? why don't they both sink alike? Well, this, to a certain extent, is in the querist's favour—that is, if the pipes are properly bedded. But, apart from this, there is another reason why clay is not good, though very useful. Clay is liable to shrink or get washed out of the joints, even though it is well puddled.

Next to clay is good mortar, as this allows the pipes to be taken up again when required; but these joints are not at all sound.

Next is Roman cement.

Next, Portland. This is no doubt much the best. But there is now something else. In order that you may be certain that no cement can run through to the inside of the pipes, force into the socket a couple of strands of spun yarn or tarred gasket; but be sure and drive it home with a caulking-tool; otherwise you will be much better without it, as you will not have sufficient room for your cement.

Asphalte is sometimes used, but I cannot say that it is so handy as good Portland.

Bad Pipe Laying.

Having the first length in and the eye fixed, next allow me to draw your attention to some bad pipe laying and its effects, which may instil into your mind the necessity of doing the work in a thoroughly good and sound manner.

Fig. 372.—This diagram illustrates a drain pipe joint very badly made; the cement being only just dabbed on at B, runs through and lodges on the bottom of the pipe at A.

Fig. 373 illustrates a drain-pipe joint properly made. Here the joint is filled up with Portland or other cement, and having the inside quite free from lumps of cement, &c.; besides the pipe here is laid with the earth well up at A. which assists to keep it from getting out of level, &c.

The effects of bad jointing, especially bad for loose earth and gravel bottoms, is shown at B, C, D, Fig. 374. At D is a joint made showing the droppings of cement through the pipes; they should be removed by the use of the wooden hoe, or wood scraper. This wood scraper is

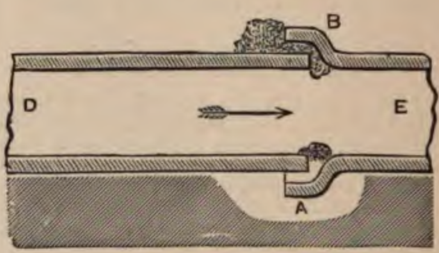


FIG. 372

simply a piece of 1in. board about 3in. round, nailed into a handle about 3ft. long. The use of this is to remove the "shirt collars" which nearly always form round the inside of the joint when it is being made. See the joint as made at Fig. 372.

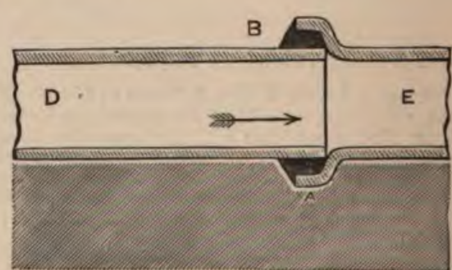


FIG. 373.

I generally use an indiarubber disc the exact size of the pipe; this may be put on the end of your cane rod and threaded through the pipe to be laid, and into the last fixed before the pipes are put together. When the joint is made, pull this disc out of the pipe, and the shirt collar will be removed.

In this illustration, Fig. 374, at A the water is seen to run and fill up the pipe, at least half full, but as it runs down the pipe, if the joints are not properly made, a great portion of the sewage runs through these joints, as at E, F, G, H. Now it will be plain that if the pipes be of a very long length the water will be all lost at these joints and get into the earth, or otherwise run under the bed of the pipes onward. The solid matter loses its water carriage, and of course stops, as at Q. This helps to bank up the water, and therefore more easily gets through the joints. This goes on, perhaps, for years, until the pipe is quite full. I have on many occasions found whole lengths of drains quite full, even in the neighbourhood of Kensington. Such drains, I am sorry to say, are very numerous, even after some of our first-rate so-called sanitary engineers have done with them. In fact, I say that nineteen

out of every twenty drains now being laid are leaky. Therefore, let me beg of my reader to carefully watch that his joining is made perfect.

sound and then the cap bedded on, and a first-class joint is made.

Fig. 376 shows another kind of drain pipe called Doulton's

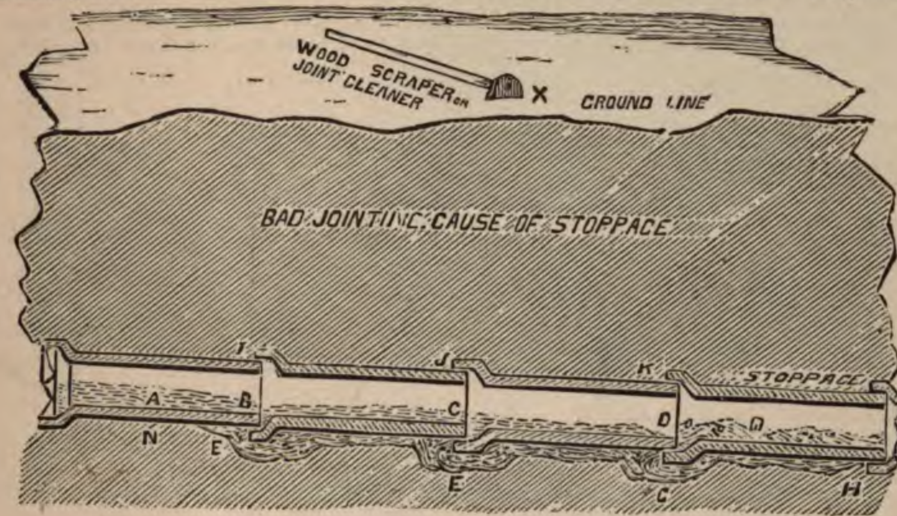


FIG. 374.

I am of opinion that we have not yet discovered the right kind of joint for drain-pipes. They are either of the old class, or too expensive. So far as regards the certainty of

FIG. 375.

making the joints sound, I think that Jennings's principle is as good as any. This is illustrated at the section eleva-

Opercular or Lidded Pipe, the object of which is to afford an opportunity for examining and cleansing.

In the process of manufacture of the opercular pipe, a partial division of the substance of the pipe is made, leaving sufficient material to preserve strength. By the insertion of a chisel the upper piece may at any time be detached without risk, and afterwards replaced with cement so as to form a good fitting cover. Of course when cement is used as the jointing material with these pipes it must be carefully

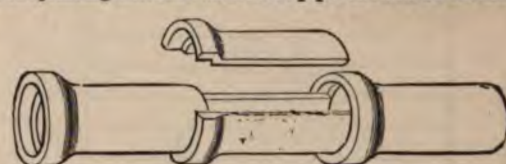


FIG. 376.

chipped out, which is a very tedious job. The best way, however, to set these pipes is with cement for the bottom part and good mortar for the top.

Fig. 377 shows a kind of joint requiring neither clay, cement, or anything else to make it water-tight. It is

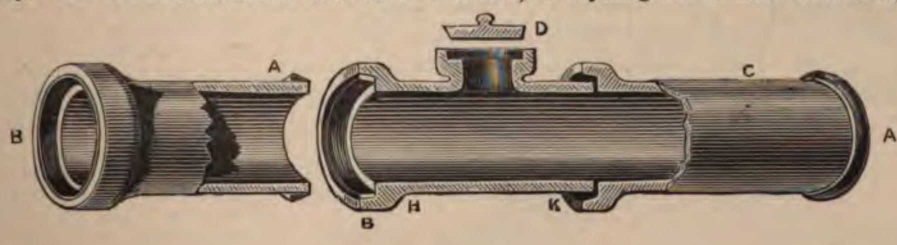


FIG. 377.

tion, Fig. 375. Here each pipe rests upon blocks; the pipe may be bedded in the earth and also into Portland cement on the block; the bottom and half up the side can be made

put together very readily, and allows of a slight settlement of the ground without destroying the soundness of the joints.

Gasket Work.

In many places people use spun yarn, or gaskets, inside the sockets. This is to prevent the Portland running through the joint, but I do not think it necessary when the joint is made as directed above, and when the hand can be got inside the pipe to face the inner part of the joint; but this gasket will be found very useful for setting the traps into the pipes, or for making good for repairs and such like.

A thin layer of clay is sometimes used instead of spun yarn, whilst at other times, in very good hard clay

Fig. 378.

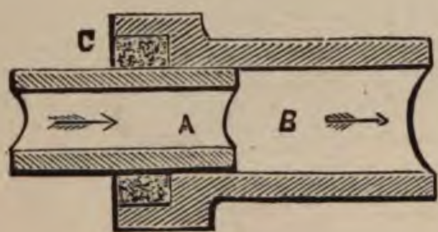


Fig. 379.

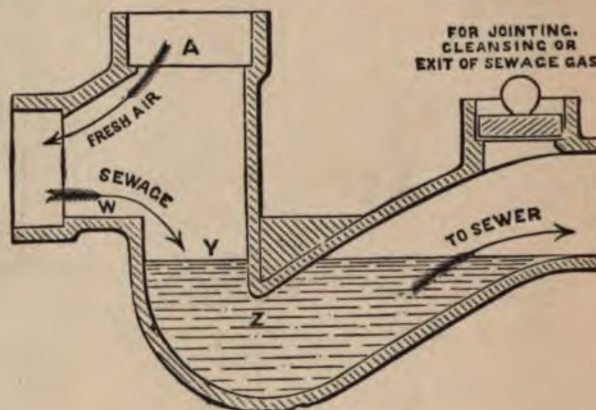


Fig. 380.

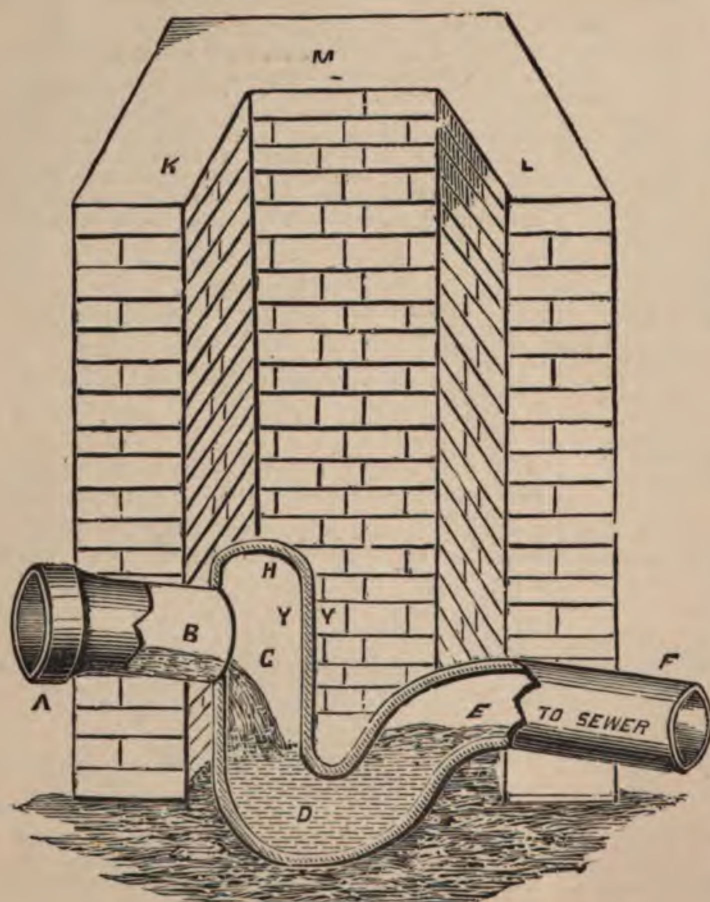


Fig. 381.

foundations, clay is used as the jointing material.

Reducing Sockets.

Sometimes you will require to put one pipe smaller into another. Many use a reducing socket, Fig. 378, but I generally make the joint, as shown at Fig. 379, by allowing the pipe to enter the other at the desired length. The reducing socket is the better plan when canes are required to be used for clearing the pipes.

Main Trap.

Having come from the sewer to the garden, area, or other premises of the house, or just inside the walls of the same, let us shut off all communication or passage for air between the sewer, or long length of drain pipes, and the house pipes. This is done with the trap. Let the trap be whatever shape it may, it is known by the names of disconnecting traps, sewer gas excluders, main trap, and a host of other names.

These traps are very numerous; many of them are mere toys, whilst others are very good. I shall recommend Mr. Buchan's as the first, *being in one piece.* This trap is illustrated at Fig. 380; it is also shown fixed at Fig. 340. You may see that in this trap there is a fall, or cathetus, or drop of about 3 inches for the sewage to knock out any sedimentary matter which may lie in the bottom of the trap. Let us now examine Fig. 381. Suppose this for

argument's sake to be Buchan's trap, B is the inlet, the sewage is seen running over the sharp lip, E is the outlet, and H the fresh air inlet. A ventilating socket or cleansing inside of the joint of the trap to the drain pipe at J. This disconnecting intercepter is made at one quarter the cost of that shown at Fig. 382, and is much better.

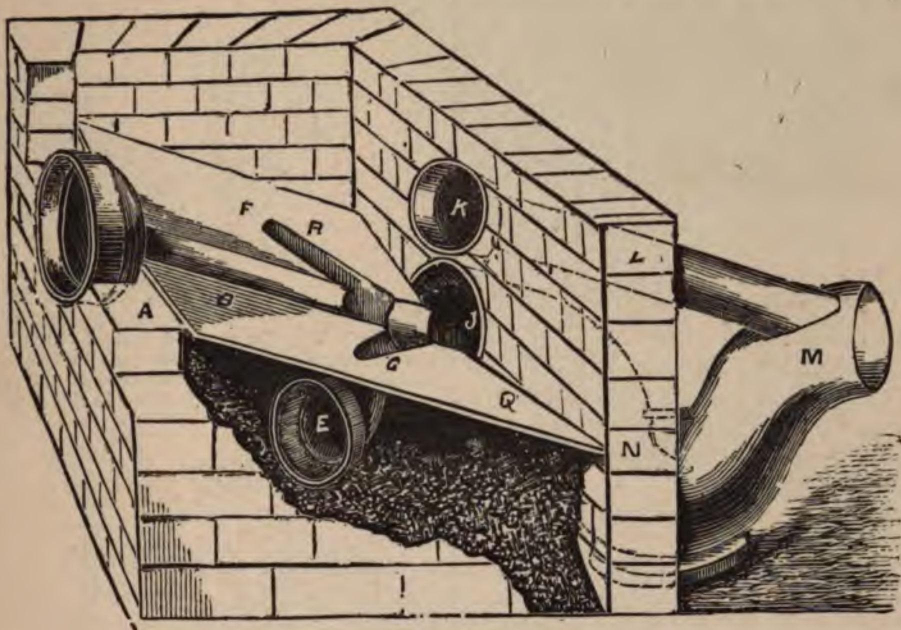


Fig. 382.

cap is at times fixed at E, so that in this trap there is everything that may be wished for. The trap is shown fixed in a manhole, but it may be fixed otherwise.

The Channel Disconnecting System.

Next examine Fig. 382. Here the intercepter is marked with channel tiles or half pipes, or they may be formed with Doulton's opercular or lidded pipes, or the junctions may be had already made. To this arrangement is attached a trap M, having a pipe K L for clearing. J is the inlet into the trap, E, F are pipes leading from W.C.'s, &c., and A may be called the main pipe. Now, with all this paraphernalia, I cannot see that it has the least advantage over Buchan's trap, except that canes may be pushed up the different junctions, which in reality is, if the drains are properly constructed with cleansing caps at the head, of no avail. Then, should this be said to be the advantage, I say it is easy enough to put an eye at Y, Fig. 381, and the difficulty is at once surmounted.

I shall introduce my system of forming the intercepter, which I contend has the advantage over that at Fig. 382, and as far as regards the trap a great improvement, to say nothing of the cost of the whole. Here, in my system, Fig. 383, are the advantages of a good deep water fall, whilst Q is the inspection or clearing hole, which may be readily looked through without having to lie down or cramp yourself up, something like a dog in a sieve. Then I have the fresh air inlet. I have also a cleansing eye, C, for taking out any solid substance which may get into the drain or trap during the time the work is being done, and lastly, I have the clearing eye B to run the canes through to the sewer. Notice this eye B also allows you to face the

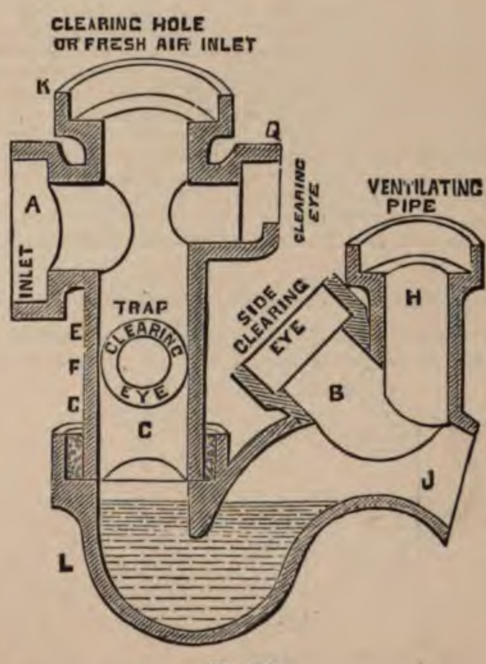


Fig. 383

The junction pipe E F G is formed with rings for easy cutting, so that it may be cut off to any suitable length.

Rats in Drains.

There is also another reason why I like this latter trap, that is because of its absolute safety against allowing rats to pass from the sewer to the house, for which see

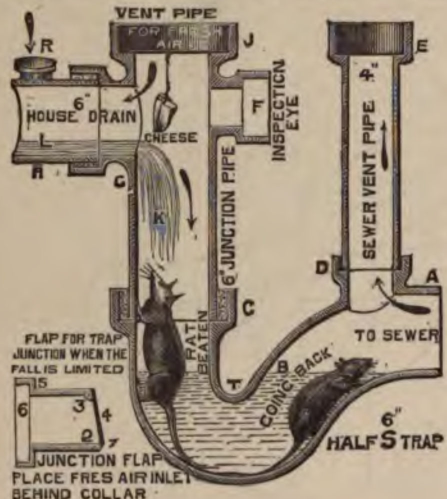


Fig. 384.

Fig. 384, where the rat may be seen in the act of trying to climb the junction-pipe leading up to house drain. Anyone can try the effectiveness of this trap by filling it with water and catching a sewer-rat, and putting it into the sewer side of the trap, as through the sewer vent-pipe, when it will be found that the rat cannot escape if the outlet of the trap be blocked up. Should the fall be too much for your levels, the same kind of trap may be used, but with a shorter junction, having an opening large enough to admit the flap 2, 3, 4, 5, 6, and whose flap-face is bevelled off on the outside edge, as shown at 7, and with the edge about ½in. smaller than the seating 2, so that the rat cannot get its nose under to lift it when the rat is "treading water." The eye or flap is connected into the junction or trap, and its collar 6 large enough to admit the end of the first pipe. Of course, the fresh-air inlet to drain must be upon a junction-pipe as at R.

Main Drain Traps of Various Shapes.

As I do not profess the power of making my readers use any one or particular trap, I think it prudent to, by

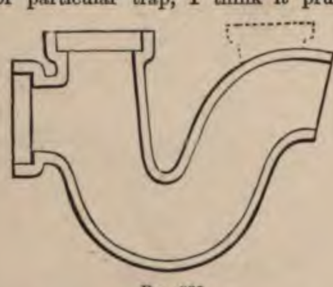


Fig. 385.

diagrams, show them a variety, and so let them judge for themselves which they prefer to adopt. In this case, I will first illustrate the Croydon trap, Fig. 385. Here is a trap very similar in shape to Mr. Buchan's, but instead of having a sharp lip it is rounded at the inlet. Next we come to one made by Mr. Daniel Emptage, Fig. 386, which is an improvement upon the Croydon. Here, in

Fig. 386.

Emptage's trap, the rounded part of the inlet (shown in the Croydon) is made lip-shaped, so as to throw the incoming water into the middle of the trap.

Next examine Fig. 387. Here in this trap may be seen

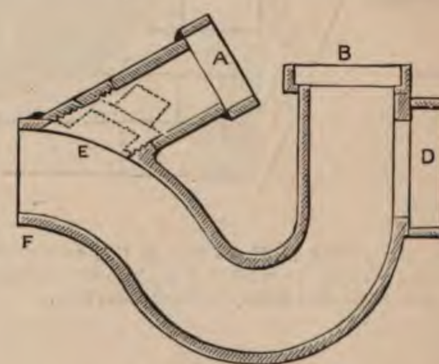


Fig. 387.

the rod-pipe socket A E, the other parts of the trap being similar to Buchan's, except the water-fall.

Fig. 388 is a very good kind of trap, being somewhat

Fig. 388.

shorter in the throat; in fact, it is simply a diaphragm, instead of a double pipe.

Lastly, we come to the old-fashioned siphon, or trap, which is simply a bent tube, which can be had with or without any or either of the sockets on the top. Some prefer this old trap to any of the new ones, on account of

its easy sweep, but, if you take my advice, you will not use it, more especially, one having the middle socket.

Let us now be done with traps, and let us examine one fixed in the earth, instead of being fixed in a manhole.

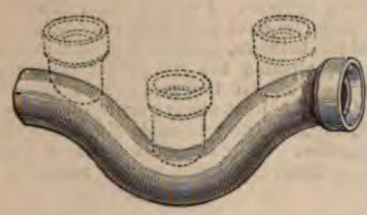
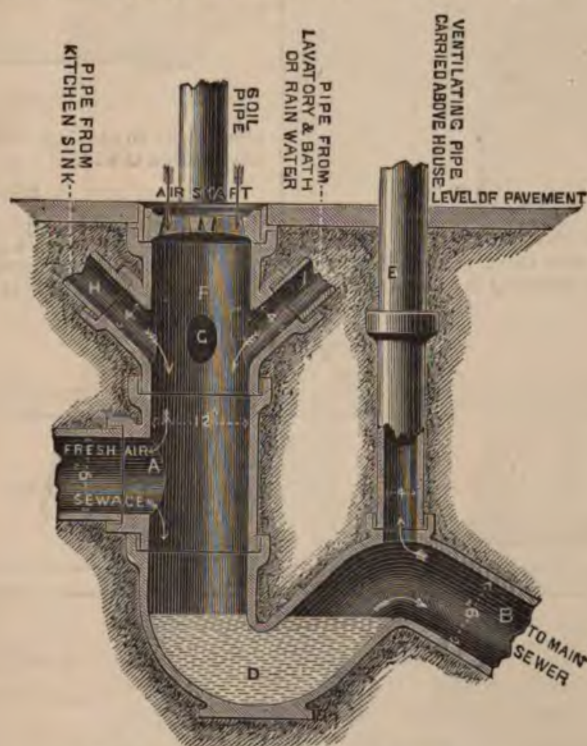


FIG. 389.

Such a piece of work may be seen at Fig. 390, having a ventilating pipe for the sewer, a fresh air inlet at the top, and branches for lavatories, rain-water pipes, kitchen sinks, etc., all fixed and in good working order; but there is one thing here to be noticed, and something which is of more importance than may at first be supposed, and that is with regard to the fresh air inlet shaft. This shaft is covered with an horizontal grating, which two out of three times is to be found partially or wholly covered up, when it at once ceases to be a fresh air inlet, and by far the better plan is to, at all times, take this fresh air inlet pipe up the side of a wall or otherwise, so that nothing can rest upon it, and as shown at FRESH AIR INLET PIPE, Fig. 396.



THE INTERCEPTER, COMPLETE.—FIG. 390

Many of my readers may ask themselves the question as to the necessity of fixing the main trap in a manhole, as shown at Figs. 381, 382, and Fig. 396. The reason for this is in order that the pipes may be periodically examined, and, if necessary, unstopped with canes, etc., but I contend that when such is the case, the fresh air inlet should be taken independently into the trap, as shown at FRESH AIR, Fig. 396, for the following reasons:—

Firstly, every one should know that a dry brick will take or soak up fully one pint of sewage water; for the same reason it will take in so much sewage air.

Now let the manhole be of the ordinary size, 5ft. by 2ft. 6in., and, say, 12ft. deep. How much sewer air will be held in this lot of bricks? It may be said that the sewage air does not pass the trap. This we will take for granted, but do whatever you may, the current of air does at times become reversed through the line of drainage on the inlet side of the trap, and more than this, these bricks do absorb the gases, and at times give them off again. That being the case, I always carry my fresh air inlet pipe independently to the top, and to a suitable place, so as to prevent the brickwork becoming saturated with sewer air. So bad was the effect of this at 4, Lexham-gardens, that the lid had to be cemented down.

Man Hole Covers.

There are various kinds of manholes in the market, some air-tight, others open; if an air-tight one is required, Banner makes a very good one, but for my part I prefer to keep the stink out of the manhole by having tight

joints, and by taking my fresh air inlet into the trap by a separate inlet pipe.

FIG. 391.

Air-Tight Stoppers.

It may be asked, how is it possible for me to make sure of perfect joints on my trap or pipes, and so keep them as

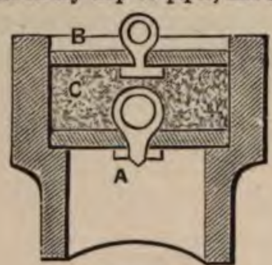


FIG. 392.

inspection holes. Well, I have found great difficulty in making the inspection and cleansing hole air-tight. If made in Portland cement, it is too much trouble to get the stoppers out; if made of clay, it shrinks, and the joint is no longer sound; so that, taking everything into consideration, I find that cast iron stoppers answer, as at A B, Fig. 392, every purpose. I simply place the stopper A in the socket, then run some just dissolved fat, or a mixture of pitch and tar, between, as at C, Fig. 392, and to prevent the rats from touching the fat (if fat is used), I place another stopper B, on the top. This can be readily withdrawn, and the joint always made sound, or the inlet junction, A, Fig. 383, may be made 3in. below the inspection hole junction. Of course, this junction pipe may be of a three or four-way junction, for receiving different branches.

Inspection Pipes.

Fig. 393 illustrates Buchan's inspection pipe, which is too simple to need any further comment. It is simply a

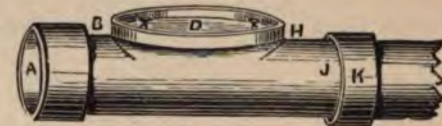


FIG. 393.

pipe having an opening, as shown at D, with cover, which can be lifted at will.

Drainage.

Now, having all your pipes laid, and the main trap in, with fresh air inlet, &c., I will give you an illustration of what the whole should appear like when finished. For this refer to Fig. 394, which is a plan of a job which I have

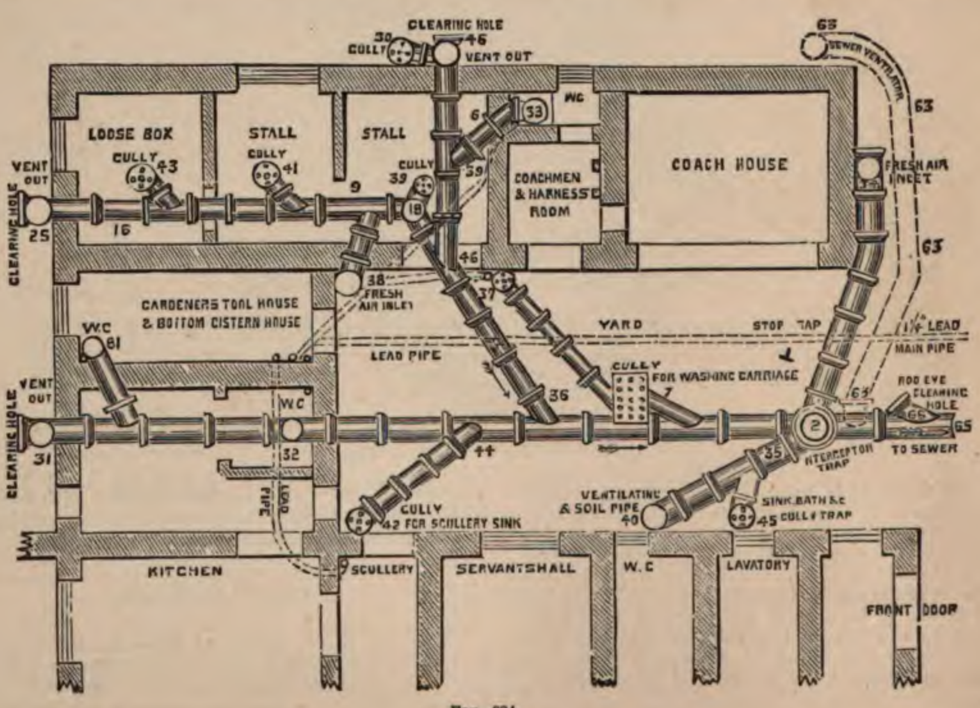


FIG. 394.

just completed at South Mead, Wimbledon Park, and which will be plain enough after the following little descriptions. No. 65 is the point where the pipes enter the premises; they come up to the sewer ventilating pipe shown by the dotted lines 63; near this junction is the rod eye 66. 2 is the intercepter trap with a drop or water fall of 11in. [see Fig. 383; also see Fig. 396, at 2, 3, and Fig. 394]; 35, 36 are branches to W.C's.; 34, 38 are fresh air inlet pipes; 7 is a

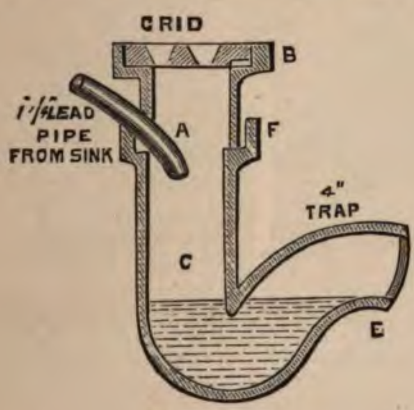


FIG. 395.

yard gully trap, which also receives the water from gully 37, for sink, bath, &c.; 9 to 16 stable piping, also W.C. At 18 is another intercepter trap to protect the horses from vitiated air, should one of the stall traps become broken, or water supply neglected. 38, fresh air inlet to stall drains; 25, a ventilating and stop end for flushing, &c.; 33, W.C.;

Notice this sink pipe, and the manner in which it enters the trap. It should be made to discharge itself direct into the centre of the trap, with a fall of at least 2ft. 6in.; this will, if the waste pipe, grating, and trap be large enough, knock all sediment out of the bottom, and so keep it clean.

Fig. 396 illustrates the drainage in elevation, and will give a good idea of the general run of the work. 1 is the intercepter trap; 2, the inspection or clearing hole; 3, the inlet into trap; 34, fresh air inlet to main trap; 6, 7, 8, 9, &c., line of drainage; T, ventilating and soil pipe; 36, gully trap for sink and bath; 16, 17, and 40, closet drain; 20, W.C. The closet is supplied with a 2in. valve and 1¼in. lead pipe. 31 is an air pipe leading 10 feet above cistern top.

Jointing.

There are many methods for laying pipes. Some people lay the pipes on a solid bed of concrete, and dig round the collar to make the joint. This is what I do when I can lay the pipes upon the solid clay, &c., as shown at A C, Fig. 367, but when I lay them in concrete I prefer to first make the concrete bed as at main drain, Fig. 396, and lay my drain pipes upon bricks as at 6, 7, 8, &c. This gives me a chance to make the joint, and to thoroughly test the work before covering the bottom of the pipes. After the joints are tested, then I lay the concrete bed and allow it to set. After this the pipes may be covered and the soundness of the drain vouched for.

Broken Drain Pipes.

Pipes broken by settlement of walls are often the cause of stoppages.

If the reader turns to Fig. 397 he will there see a line of drainage put in in such a manner that the settlement of

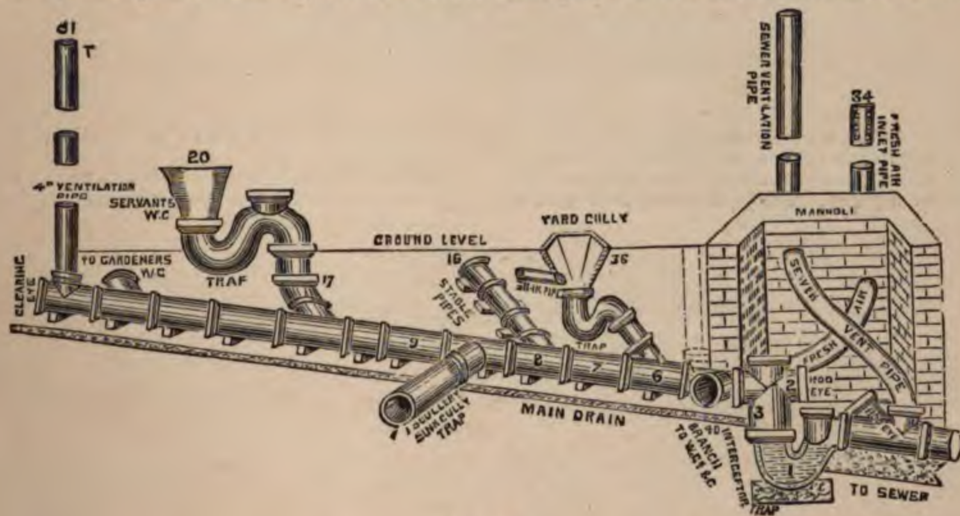


FIG. 396

30, gully trap for coachman's top sink, waste pipes, &c.; 32, servant's W.C., with 2in. ground-in spindle valve, and 1¼in. lead pipe from a seventy gallon cistern 12 feet above the W.C. basin, and which cannot discharge less than 4 gallons each time the wire is pulled to W.C.; 42, are the pipes to scullery sink. [For elevation of this gully trap and lead pipe, see Fig. 395, which almost explains itself.]

walls, A B, cannot hurt it. Let him next examine Fig. 398, which exemplifies the effect of building a wall upon a drain. Too much precaution cannot be exercised when building a wall that the brickwork or concrete does not rest upon the pipes. There should be at least one brick left out above the pipe, so as to allow for any settlement. Otherwise, if the wall be not watched, settlement is likely

to lead to the breaking of the pipe at this point. See account of this kind of thing in the *Builder*, Sep. 25, 1880, page 377; also see Fig. 398.

This figure shows the wall built upon the pipes, after two years' settlement. This was a wall at Mr. Busher's, draper, No. 2, Campsbourne-terrace, High Street, Hornsey, altered by myself in the year 1871.

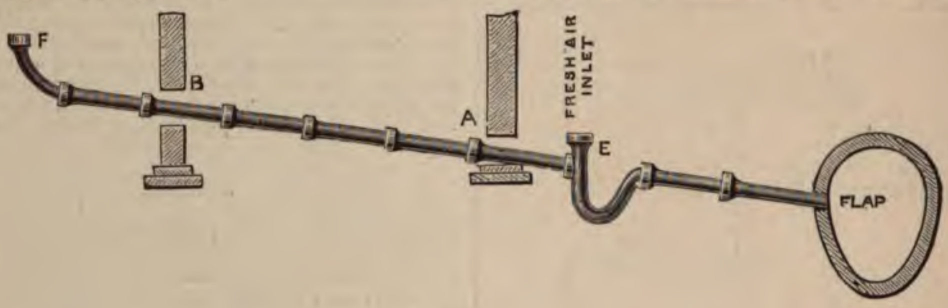


Fig. 397.

Pipes broken through not being properly bedded are often the cause of stoppages.

Fig. 399 shows how the pipes break by the pressure of the earth when the pipes are not properly bedded, but left only resting upon their sockets, as at E E E. This often takes place when the pipes are laid on hard ground, such as marl or dry clay. The pipes should be bedded as at Fig. 373, or as at Fig. 398, which shows the ground all round the pipes.

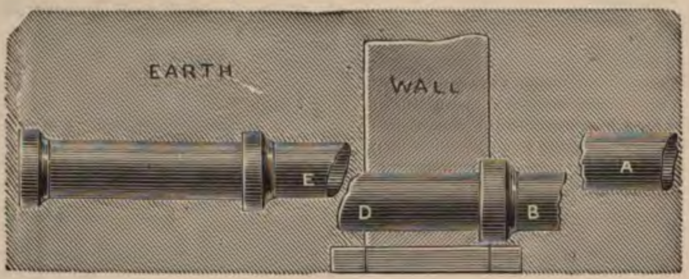


Fig. 398.

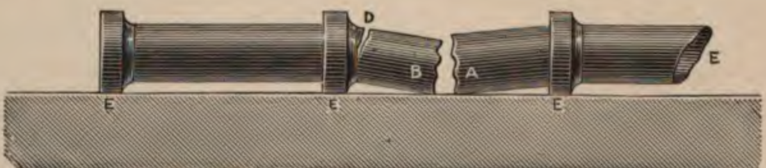


Fig. 399.

Testing Drain Pipes and Joints.

You have now come from the sewer up to the trap. Are all your joints sound, and without the cement running through at any of them? and do you require to prove that they are sound (we say "sound" when we mean that there are no leakages)? In order to ascertain whether any of your joints leak, stop up the outlet end at the sewer by placing a wash-leather over the front of the flap, or put some clay round the seating of the valve, and charge (fill up) the pipes with water. If there be a loss you may accept this as an indication of bad work. Be sure to examine the trap as to soundness, before it is fixed, by charging it with water—there is no other reliable method; it is no use to sound it—and you are so far right. But if you have a loss, it is most probable that there is a leakage at the joints.

Testing Drains, Soil Pipes, and Fittings generally.

In these days we have thousands who profess drain testing, and who make it a good business; but out of the thousands we may safely say that 999 in every thousand are thorough outsiders, and know no more about sanitary plumbing than a donkey does about poetry; and the few that do understand the work are apt to be so conceited over their precious fads that it is sickening to be in their company. One goes in for strong, pungent chemicals; another for pressure by air; another, pressure by water; another for smoke; whilst others are contented by something in the way of a strong whiff, which has served to stimulate or agitate the olfactory nerves, and which, at any rate, leads him to suspect strongly, when he may be heard giving a sort of colloquial phrase, and will soon indicate his

ideas and instructions by pulling down the casings or up the floors, &c. This is all very well, taking a broad view of drain testing. I am convinced that each of the above tests will answer under certain *conditions;* but there are conditions when one test will answer, whilst the other will not, and at other times none will answer. For instance, suppose your drain to be down some 10ft. or 12ft. below the ground floor of your house, and the drain to be well covered with close soil; no smells are perceptible, but the drain is out of order—it is choked. In this case, all the strongest odours which you may name will not prove this, if the joints above ground be tight. Examine the diagram, showing the drain at G E E, Fig. 374. Here the water runs out at the bottom of the joint, and runs below the pipes; the solid matter is left to accumulate in the drain pipe, and soon becomes blocked. In this case, go into the sewer, and get someone to call up the pipe. If you cannot hear, perhaps there is a trap or blockage which prevents the sound from passing; then run your sweep's rods up or down, and most likely you will clear the drains. Now, let them stand for a few hours without water being allowed to be thrown down, then throw down a certain quantity, say for every 100 feet one pint of some kind of liquid, and see whether this comes within a reasonable time into the drain. If not, the chances are that it has run through the drain pipes into the earth, because if you pour one pint of any liquid through a well-constructed drain after it has been once used, you may expect to get a pint (or, at least, within a shade) out at the fall.

In Kensington, I have often found defective drains in this manner, even after the drains have been supposed to have been put to rights. Of course, if you could stop up the end of the outlet, and charge the drain with water, this would answer the purpose of the above. Here you see that the smoke test would be useless, because you cannot get it to pass through the earth, and chemicals are as bad.

The Peppermint and other Chemical Tests.

Many plumbers about London test their drains with oil of peppermint, musk, 2 oz., or sulphurated ether, 6 oz., nitro benzole, oil of aniseed, oil of thyme, oil of murbane, or artificial almonds, &c., but many of those who attempt to do so do not understand how to do it in an efficient manner: they simply throw the peppermint, or otherwise, down the soil or air pipe, and consider that that is all that is required, but this is not the case; nothing is more important than to do it efficiently, which should be done as follows: First, if you have a fresh air inlet, stop it up, and all other openings in sight connected with the drain. Next, take two or three ounces of Hotchkiss' oil of peppermint, and see that there is not the slightest trace to be found on the outside of the bottle, or most likely this will spoil your test. Now have about a gallon of boiling water, or sufficient for what you think will answer to carry the chemical into your drain and go to the highest point of the soil or air-pipes, and carefully pour down this pipe the peppermint, after which quickly pour down the hot water and stop up the end of the pipe. Be exceedingly careful not to spill the least traces of the peppermint about your hands, &c.; then run down through the house, and to the places which you suspect, and see if you can discover any traces of your oil of peppermint smell; if so, it is a certainty that something is wrong. You should have an attendant drilled in the work with you.

The sulphurated ether is applied in much about the same manner as the peppermint was, but will require three times the quantity, and caution must be used not to get a light or fire near it, or it will explode. It will hang about for weeks. Oil of aniseed and nitro benzole have much about the same effect as the oil of peppermint.

The Smoke Test.

Some plumbers will use the smoke test, which is done by burning tobacco paper, &c.; Fig. 400 gives a pretty plain view of what the machine is like, and which is known by the name, Asphyxiator. In this you see a funnel or pail-shaped bowl into which you place the tobacco paper; place the end of the tube in close connection with the drain pipes, stop up the air or ventilating pipe, fire the tobacco paper, and turn the handle on the wheel; you will at once produce a suction through the bowl which will bring the fumes of the tobacco paper into the tube and into the drain.

FIG. 400.

After a little time the drain becomes charged and the smoke finds its way through all untrapped openings in the house, through small holes which may be corroded through the soil pipe by sewer gas, through defective plumbers' joints, or uncemented or broken joints in the earthenware drains, &c., thus, both olfactorily and ocularly demonstrating if the work is not sound, or if there is any opening for sewer gas. When a proper disconnecting trap has been put in between the house and sewer, or cesspool, with an inlet opening for fresh air, as shown at MAINTRAP, Fig. 340, &c., the trap can be used for the inlet of the smoke without disturbing the drains; or, if the gulley trap in the yard is emptied of water, this may be used, but in the latter case if there be no main trap it will be of little use, inasmuch as you do not get much pressure of smoke, as a large quantity of the fumes will escape down the sewer or other outlet.

Some strips of brown paper which have been soaked in vinegar and saltpetre will answer in lieu of tobacco paper for testing waste pipes and such like.

Testing for Traps.

If it is required to know whether there is a trap on a line of pipe it may be ascertained by using a chimney-sweep's machine, or if the drain is clear a man can be set to call through same from sewer to any part of the drain.

Junctions.

Many jobs are spoilt by fixing junctions which are not suitable for the class of work, for instance, some people never think of anything but just getting a job done, and will use any kind of fitting that they can lay their hands upon.

Branch pipe should never go into a drain at right angles, as shown at Fig. 401, but as that described at Fig. 402, which is known as a Y junction, suitable for a branch coming in with a very easy sweep. Fig. 403 is a junction for branching at right angles, though rounded to a sweep

into main pipe past the socket. Fig. 405 is the Y junction for branching two pipes into a right line of drainage. The

FIG. 401.

FIG. 402.

FIG. 403.

junctions may be smaller or of the same size as the main pipes. This diagram shows two small pipes branched into one large.

Before we proceed further with these junctions let us see why we should have the branches to come at an easy angle. Let us take Fig. 401 and examine same.

If you consider the water to be a ball, and the same to be in motion, and dropping from an upright point on to a plane, there it will stand dead still; or if it be an egg

FIG. 404.

FIG. 405.

it will break and fly equally in all directions. But if you let this ball fly on to an oblique or slanting piece of board, then it will fall off, as will the egg, without breaking, according as you place the board. The same effect takes place with regard to water, &c., when running through pipes.

Motion of Water round Bends, &c.

By adopting an easy curve in junctions you will entirely avoid eddies in the main pipe, and the velocity of the water will be very little altered, especially if you give the customary additional fall to these curves or junctions.

Cause of Eddies.

Never place the junction-pipes to fall perpendicularly or vertically over a main pipe, for, by so doing, eddies are caused, which throw back and up the drain, part of the solid substance contained in the sewage, and which accumulation above the junction afterwards becomes the bar to the water passing the main pipe. Should a stream of sewage be passing the main pipe when the bad chosen junction is at work, the stream in the main is bound to be greatly diminished; so much so as to cause the drain to become full, whereas, had there been no junction it could not quarter fill it. These are the little points which are very rarely attended to, and are the points which I particularly wish to draw your attention to.

Bends, Springs, and Set-offs (Earthenware).

Next are the bends, which should be selected with due care. Fig. 406 is the ordinary square-bend; and Fig. 407

FIG. 406.

FIG. 407

FIG. 408

an easy bend; and Fig. 408, a set-off. In fixing bends always give a little more fall than you do to the ordinary pipes, to make up for the loss of velocity.

Formation of the Branches.

DRAINS TO RECEIVE SOIL-PIPES.—These should be brought up to within 6in. of the floor line, and the back of the socket let back into the brickwork to allow the soil-pipe to come in a direct line into the pipe part of the drain-pipe, say about 3in., then you can cut a lead flange to fit the socket, and fill up the socket with Portland cement. The drain should not be trapped between the intercepter and soil-pipe, *in order to obtain a direct current of fresh air through the entire length, and, if possible, at the highest point of the drain,* whether this be either inside or outside the building. My experience tells me that under any circumstances the soil-pipe should always be of good stout lead with proper wiped joints.

DRAINS TO RECEIVE SERVANTS' W.C's.—It is always best to have the hopper and trap ready for fixing, to guide you as to the exact spot for bringing up your drain-pipe. Should you not have these, then bring up your drain to within the wall of the closet, or if it comes through the doorway leave it about central to the W.C., so that you can take it either way. But, as before said, it is always best to have the hopper and trap. If you have these, work as follows:—For ordinary closet pans or hoppers fix the centre of traps central between the two walls, and at such distance from back wall as will let the front of the pan stand 22in. from the wall. Or, if it is to receive a pan-valve or other closet, the centre of the trap should stand 12½in. to 13in. away from the back of wall and ½in. out of the centre of the closet; the ½in. to allow the handle of the closet to come within the bounds of the flap. For valve closets fix the trap 14in. from back of wall and ½in. to 1in. out of centre; the narrower the closet the more it should be fixed out of centre. If you keep these distances from the back they will give a nice seat and allow you to have a flap that when lifted up will stand back; it also gives you a chance to bring the lead pipe into the arm of the basin.

Take notice that you do not fix either trap or drain-pipe in the way of the riser, or in the way of the valve, which is always placed on the right hand side when sitting down upon the seat. [For fixing traps also see Figs. 455, 456, 457, 458, 461, 462, 463, 464, &c.]

Hoppers and Basins for, Height to Fix Traps.

Here you must know what kind of basin is to be fixed. You can have hoppers such as Fig. 409 from 17in. high;

FIG. 409.

balloons or cottage basins from 9in. to 12in. high. This is without the traps. These should be fixed for adults' closets from 16in. to 17in. high. I always fix them 16½in.,

FIG 410.

unless I know the persons likely to use them. Remember that men's closets should always be the highest. Also take notice that the basins are the right size at bottom to enter

FIG. 411.

the top of the trap, as it is not all basins that will suit every description of trap. *Important.*

You see that in order to get the right height of the trap you should know the basins, which run as follows. Fig. 409 is a tall round or long hopper, and Fig. 410 is a short hopper, whilst Fig. 411 is an oval basin, sometimes called a "balloon basin" or "cottage basin," having Sharp's flush rims, to dispense with fans and screws, &c., also see Fig. 547. You will see that, if anything, this pan requires the trap a little nearer to the back of the wall than the tall hopper. But, if the basin is not to be had, fix the trap as stated and build seat to suit pan. N.B.—Some joiners make the seat beforehand; in this case, tell them to make the seat and flap wide enough to allow for cutting. They are generally made 2ft. from front nosing to back, and 17½in. to 18in. high when finished. See that there is sufficient room between the closet seat and door to allow the door to properly open.

Speaking of the position for the trap, I may say that it is most important that the class of closet and trap should

FIG. 412.

be known before the pipes are brought up to receive them; for instance, you may get a Sharpe's pattern basin and trap as shown at Fig. 412, but if the pipe is not somewhat near the mark the basin cannot be fixed central.

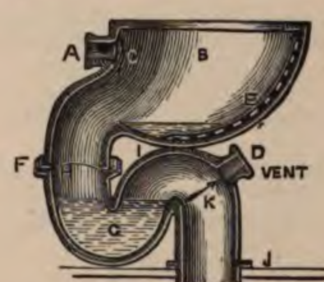


FIG. 413

Then again, you may have the basin or trap in one piece, or the basin and trap as shown at Fig. 413; also see Fig. 549, &c.; here the pipe should be fixed central as at J.

Hopper Traps.

Fig. 414 is the proper kind of trap for a balloon or cottage basin, as Fig. 411. This trap is often very improperly called a ᴗ-trap. It is really only a half ∞. It may

be had with lugs on bottom for screwing down to the boards when required [see H, Fig. 412].

FIG. 414.

Fig. 415 is the same thing, only having the outlet turned over a little more, and is called a three-quarter ɷ. It is employed with pipes coming up at an angle.

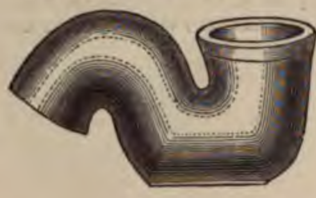


FIG. 415.

Fig. 416 is the same principle, but a complete ɷ, suitable for pipes coming up in a vertical position.

These traps may be had with cleaning out holes, or

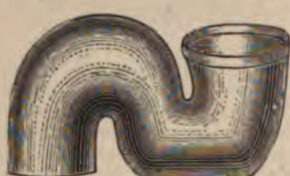


FIG. 416.

inlets on their backs, as at dotted lines, Fig. 418. This does for a ventilating or air-pipe; for this also see Fig. 494, &c.

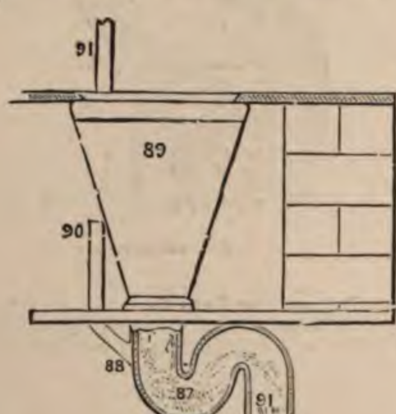


FIG. 417.

Or you may have the ɷ-trap with an arm at the heel of the trap as at 88, Fig. 417, for fixing a supply pipe, in order that the trap may be more readily cleared.

Drains to receive Rain-water Pipes.

These should be all trapped at the foot or bottom, unless all and every branch of pipe runs, at least, 18 feet above the top or attic windows, and all the joints are thoroughly stopped with red and white lead. The kind of trap varies from Fig. 415 to the gully trap, Fig. 419, or the reversible intercepters, Figs. 419 and 420. It is not at all uncommon to take the rain-water pipes direct into the intercepter traps, or to make them discharge over the grating of a gully trap, the latter of which plan is not good, although much practised in London.

If rain-water pipes discharge over traps that become dry, these pipes often convey the sewer air into bay and other windows, and various places not thought of, especially through air-gratings [see Area Traps].

Area or Yard Gully-Traps.

Figs. 418, 419, and 420 (and at times 421 and 422), are

FIG. 418.

used as yard gully-traps. The yard or area gullies are often put in without any thought as to the manner in which they are to be supplied with water, and consequently stink

FIG. 419.

the whole side of the house that is near or above them—generally, the front of the house.

FIG. 420.

When practicable, it is as well to make this gully the receiver of some sink, wash-basin, or bath. It should never

be left to chance for supplying itself. If this cannot be done, the pipe should be taken to the nearest supplied trap, or even to the intercepter.

Sink Drain.

Sink drains should be constructed in such a manner that they may be readily cleared out, and to suit the different work which they are required for. In some cases the ordinary gully-trap (as Fig. 418) with a square top and grid will answer very well; and even Figs. 414, 415, 416, and

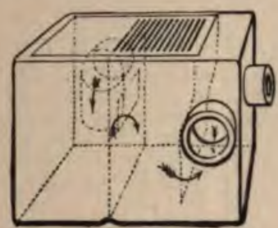


FIG. 421.

421, 422, are in some cases, especially for Butler's Pantry Sinks, used.

Figs. 421 and 422 show one of Manserg's External Traps, made by Doulton's, which works well for receiving wastes and overflows from baths, lavatories, and sinks which do not have grease thrown down them. The arrows indicate which way the trap works, and show how to fix it.

Scullery Sink Traps.

Here it is necessary to use the greatest care, for half the drains in large houses are deranged by the fat entering them from the scullery sinks. For the last twenty-five years, I have watched the working of scullery sink traps, and am of opinion that some kind of fat trap should be used where there is much cooking going on, whilst at other houses, double the size, a simple gulley trap will be found to answer

SECTION.A.B

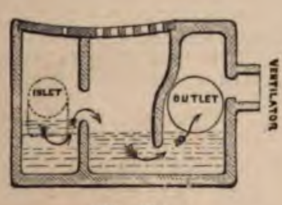


FIG. 422.

every purpose. This very much depends upon the class of cooking and the cook, whether she be of a saving class or not. However, I shall only say that since Buchan's trap, which was patented in the year 1879, there are plenty of others in the market; of course, you can make one to suit your work, such as the one described and illustrated at Fig. 298.

Whatever fat trap you use, it should be large and roomy, to hold a good quantity of water, in order that the latter may immediately set or solidify all grease before it enters the main drain. Unless this is done the main pipes will become clogged up with fat. Secondly, that the trap shall be easy to open and clean out. Thirdly, that it shall be a secure and proper trap against all sewer air or gas. Fourthly, that it will effectually prevent rats from passing to and from the sewer to the house.

Buchan's fat trap is illustrated at Fig. 423, and Doulton's

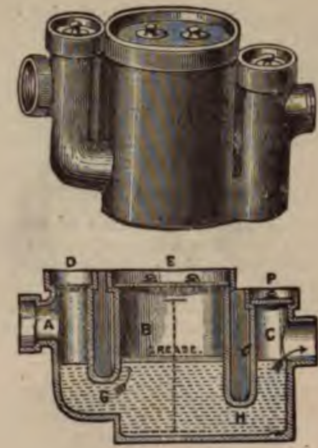


FIG. 423.

fat trap is illustrated at Fig. 424. Some plumbers prefer the old-fashioned dip fat trap. For those who prefer this trap, I give the following method for making it.

This trap may be constructed as follows :—The size given here is suitable for a twelve-roomed house; larger houses require increased sizes, as may be judged necessary for the work.

This description of trap is built with about two hundred stock bricks, and plastered round with Portland cement, two and one, or one and one, or as may be preferred. The dipstone should be fixed nearer to the outlet than the inlet, because most fat stops in the inlet end. This stone should be cemented into the sides. Then a flagstone is required for the top.

The inlet pipe should over-sail or protrude into the trap, and be at least 18 in. above the outlet, as a check against the rats; but if this is not practicable, as much should be

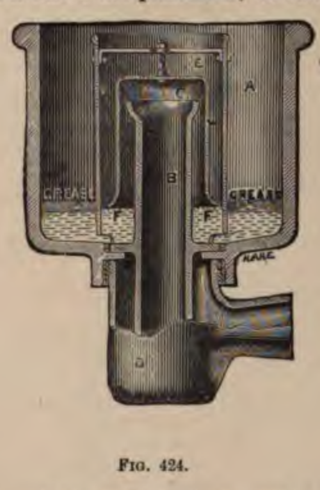


FIG. 424.

obtained as possible, at least 6 in., and a flap should be fixed on same, which cannot be opened by a rat when in the water, that is, if he cannot get his paws on anything to pull himself up with. Here is one reason why the pipe should protrude and dip into the trap.

This trap is inside measurement 2 ft. 6 in. square and 2 ft. deep. The sides and ends take about 160 bricks, and the

bottom about 32, so that 200 will do the job, and if built with sand and Portland cement, one sack of Portland will be sufficient.

Put a ventilating pipe on the inlet pipe, and if another such pipe be desired, well and good: the trap will be none the worse for it. In that case a single junction should be fixed. Of course, there may be as many inlets into this trap as desired.

Awkward Workmen and Forgotten Work.

One of the most unfortunate parts of our business is having to put up with the whims of awkward workmen. Fig. 425 illustrates too plainly what I mean, and it is to these workmen that I wish now to speak. Look at this diagram which shows the effect of leaving the job unfinished, and quarrelling about the things not coming up like clockwork. A drain-pipe is put in before the walls are built, or

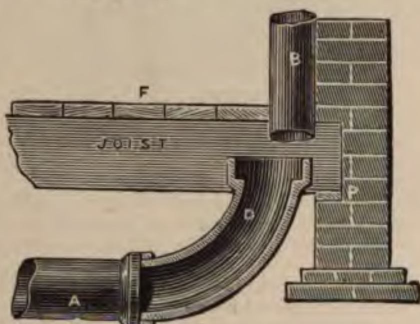


FIG. 425.

before the soil-pipes. It is put in, as one man supposes, to the exact place, height, and position, and as he thinks, will make a first class job; with the addition of the bend D, he prides himself that everything is first class. Next, the soil or other pipes are fixed before the bend is put in. This is done by the plumber. The work is contract to him, and he gets his pipe up as quickly as he can, and takes it to the usual distance below the floor, namely, about six inches, of course never dreaming about making a set-off to suit the drain-pipe; nor is it at all customary to do so; in fact, the soil-pipe B is in as it should be. Next the foreman gives orders to the person who laid the drains to go and make good. The latter takes his bend, and is disgusted with the plumber's work. It is not long enough. The soil pipe requires a bend or set-off, and to come lower down to suit his work. "He'll fix his bend, and let that humbug of a plumber alter his arter." He fixes the bend, never cutting the brickwork away for letting the socket of the pipe go back, so that the soil pipe shall properly enter same. No; the plumber shall bend his pipe. This is never done; the floor is laid, and all is forgotten. Nobody sees anything. "Out of sight out of mind." There are thousands of pipes, as this figure, about London, and as for butlers' pantry sinks, I have every reason to believe that the greater part are never made good to the drain.

Rats and Stoppages, Stinks, &c.

It is not at all uncommon to find drains blocked up by the rats having worked the earth through the imperfect part of the jointing, for when the hard-working rat goes tunnelling, he brings all the earth into the drain. He will put a peck of earth into a drain in a single night, which is often sufficient to entirely block up the sewage passage in drains with little fall.

Clearing Drain Pipes.

Should you want to clean out the drain, the machine, like the canes of a chimney-sweep's kit, is the best tool. It is fitted with a screw, a draggle hoe, and other implements for drawing out solid matter, and is a very handy tool.

Forcing Water Closets.

It is a very common occurrence for closets to become choked up from not using sufficient water, or by the use of too much paper, &c. When this is the case a plunger may be made out of an old broomstick, and a stiff piece of leather nailed on the same (the leather should be round and about 3in. in diameter), or if no leather is at hand a plunger may be made to the above size by tying a good piece of rag on the end of the broomstick to the above diameter. It should be tied tightly on the stick. The plunger may then be worked up and down the closet near the bottom, but not rammed down so as to knock the bottom out of the trap; for if gentle working will not do it, that is proof there is something else there besides paper. The next job is to fish out the impediment, either by the operation of stripping up his shirt-sleeves, or as best he can. Frequently he will have to cut it out at the trap. If so, care must be exercised not to break the trap, to cause it to lose water (very important). Here it is handy to have the socket on the top of the trap, as shown at Figs. 225 and 418.

SOIL AND RAIN-WATER PIPE WORKING;

Also Tacks, Ears, Astragals, &c., for Soil and Rain Water Pipes.

Before we can proceed to fix our soil or rain water pipes, it will be necessary to know something about what we are going to do, and by what means they are to be suspended, the kind of joints to be used, and also the class of finish, &c., &c. The soil pipes may be seen fixed in many of my drawings, some being fixed one way and some another; sometimes in chases, as shown at Figs. 565 and 566; sometimes in the angles of walls, and at other times on a straight line of walling. For the elevations showing these pipes so fixed, also see Figs. 339, 340, 474, 472.

Fig. 474 shows the pipe at N Q fixed with single tacks, M shows this part of the pipe fixed with a double tack, whilst Fig. 472 illustrates the soil pipe fixed with all double tacks. Sometimes the pipes are fixed in such a manner that tacks cannot be used; they are then fixed on blocks with flanged joints, as shown at Figs. 151 and 152, whilst at other times they are supported with secret tacks.

Secret Tacks.

These secret tacks are shown at N J, Fig. 426, also at W S R D, Fig. 427, and may be readily understood from the following description. The lengths of pipe vary from 3ft. to 6ft., having four or five inches of the front of the pipe cut away at the top, as shown at B S R Q, Fig. 427. This is to allow of a wall hook being driven in at the back, as at W, Fig. 427, and as also shown in the plan at N J, Fig. 426.

It will readily be seen that with these tacks the whole line of pipes may be fixed without an ear being seen, the

wall hooks, &c., always being behind the pipe. Sometimes the top part of the pipe is bent over, so as to form a kind of flange, as shown at B Q, Fig. 427. This flange is fixed with wedges or wallhooks into the joints of the brickwork. Of course astragals may be fixed round the front of these pipes in the usual manner. It will be seen that with this kind of secret tack the joint cannot be wiped, so that for soil pipe work the secret tack must be put on somewhat differently; in this case an independent tack is used, and the lead should be much stouter and about 18in. long, and soldered on the back of the pipe, as at P, Fig. 430, and in such a manner that the pipe can be pulled forward for making the joint, whilst the tack is fixed as at A for supporting the bottom length, where the pipe is there shown ready for the top length to enter.

Sometimes the chases, where soil and other pipes are fixed, are lined with boarding; sometimes the board only being at the back, whilst at other times the boards are all

Fig. 426

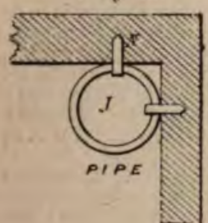
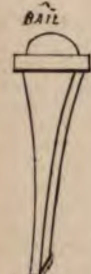
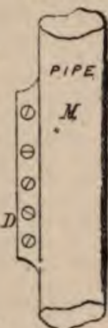


Fig. 428.





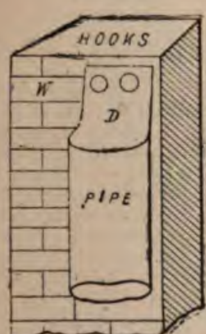


Fig 427

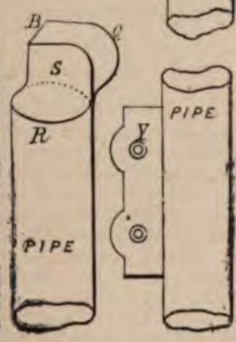
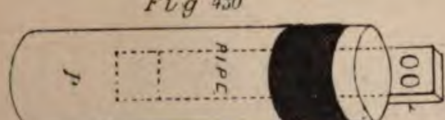


Fig. 429

Fig 430



round: and when this is the case it would not do to drive wall hooks for supporting the pipes, and therefore a different class of tack must be employed. This tack should be made from short pieces of stout leaden pipe and somewhat longer than the ordinary tack, in order that you may use, say, 1in. or 1½in. stout screws, as shown at M D, Fig. 428. The reason for using this stout lead and the tack of greater length, is to enable you to get sufficient lead hold, or surface, for supporting the lead, which otherwise would most likely tear the tacks where the screw enters. These tacks are known by various names, such as narrow tacks, tacks without flaps, face tacks, stout tacks, heavy tacks, &c., &c.

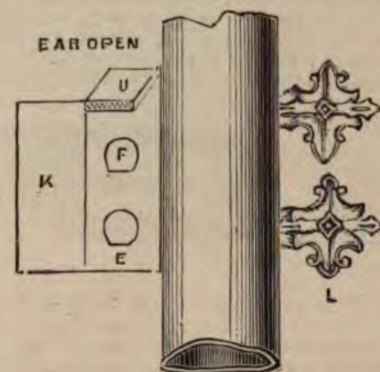


FIG. 431.

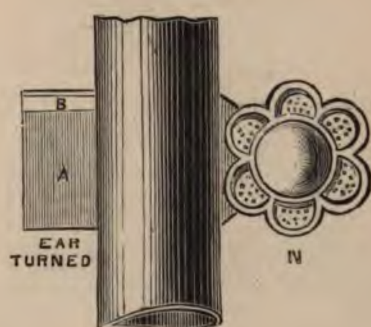


FIG. 432

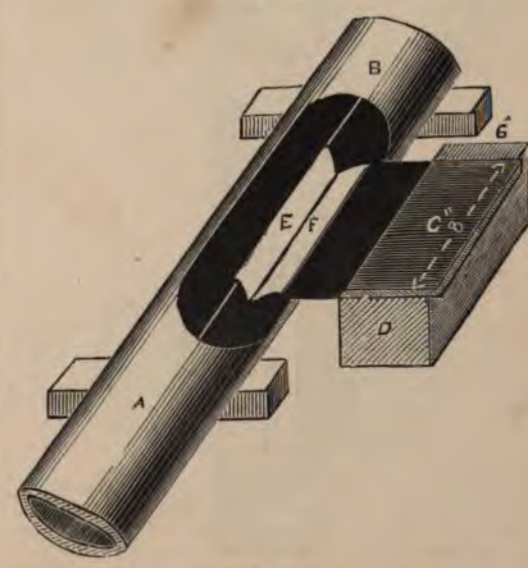


FIG. 433.

We will now begin to prepare a length of pipe suitable for the tack; for this turn to Figs. 433, 434, and 435. The length of the tack runs longitudinally with the pipe. For pipes from 2in. to 6in. diameter the length of the tack should be double the diameter of the pipe, *i.e.*, a 4in. pipe requires a tack 8in. long; the width of the tack should be in proportion to the pipe as $1\frac{1}{2}$ is to 1, *i.e.*, a 4in. pipe requires a 6in. tack, and a 6in. pipe a 9in. tack; this allows the wall hooks, E F, Fig. 431, to be driven home without injury to the side of the pipe, and allows sufficient

FIG. 434.

lead, as at K, to turn back over the hook, as shown at A, Fig. 432. Of course these odd tacks are shown here for the sake of illustration only; it would never do to fix odd ones, as your work would appear like a pig with odd ears.

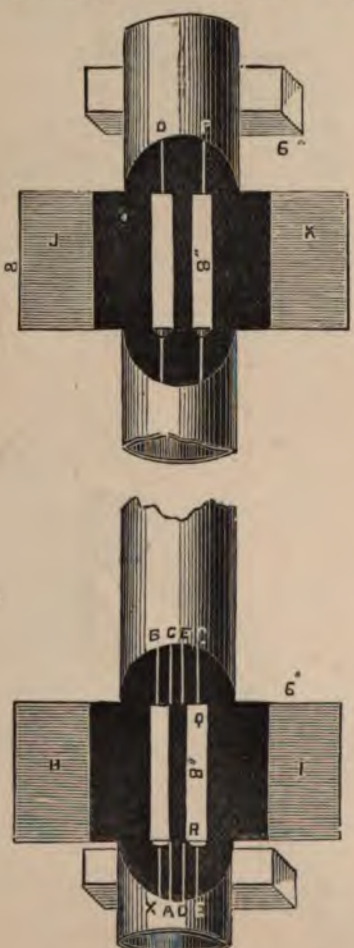


FIG. 435.

Each 10 feet length of pipe should have four ears or tacks. In preparing these ears for soldering on, first rasp off the one side of the edge, soil it 4in. up, and with a large guage-hook or straightedge and shave-hook, shave it from $\frac{3}{4}$in. to 1in. wide, then touch it, and with your dresser (just over the edge of the bench) knock the shaved part round or back as shown at F, Fig. 433. This should not be turned back to exceed $\frac{1}{2}$in. This will allow you plenty of room for solder when it is wiped flush with the back of the soil pipe [see 8, R Q, Fig. 435].

Preparing the Pipe for Ears or Tacks.

Having settled upon the size and kind of ear, and the position for same upon the pipe, the next thing to do is to soil the parts for the tacks.

For this purpose, take a chalk line, and strike the width for soiling as shown at A, B, C, and C, Fig. 434.

Then soil to the lines, but cut the end of the soiling round as shown at A F. When this is left square as at J K it appears ugly.

Having dried the soiling, by either allowing it to do so of itself, or by placing a little lighted shavings in one end of the pipe and elevating the other to cause a draught, or by holding a hot iron near it, and with your mouth blowing air on to the side of the iron in such a manner that it will become heated and rebound on to the soiled part; next with the chalk line strike the shaving lines, A B E F, Fig. 434, and X O E P, Fig. 435.

This will keep the shaving in a line. Then, take your tack and mark the exact length for shaving, and proceed to shave the joint ready for soldering. Next take a brick, or the like, as shown at D, Fig. 433, and lay one end of the tack upon it, and the other on the shaved part of the soil pipe, as shown. Weight the tack so as to prevent it moving, and proceed to solder as follows.

Soldering on Tacks.

Take a ladle full of metal, and with a splash-stick splash the metal on until your heat is well up; or, if you are a proficient workman, pour it on. Keep the edges alive, at least 1in. over the soiling, and when you can feel it all upon the slop, take a warm cloth, about $2\frac{1}{2}$in. square, and begin at Q, Fig. 435, and the moment you are 2in. away, let the mate cut the surplus metal square off, as at Q. Keep on wiping. By this time you are at the end R, when your mate again cuts off the surplus solder square as shown at A B C D, Fig. 436, &c. To prevent little spurs of solder hanging under the tack, let the mate, with a pencil-shaped pointed stick, rub them off whilst hot. If you are up to your work you can do all this without troubling the mate; such jobs are considered stock jobs for apprentices, &c. For a good plumber to use irons in this class of work appears to my mind superfluous.

Single Tack Work.

A B C D, Fig. 436, illustrates that which is known as single tack work. Of course, four such tacks must be fixed upon every 10ft. length of pipe.

The fixing of single tacks supports the pipe much better than the double tack work shown at E F G H, Fig. 437, for the following reason, that the tacks in Fig. 436 are distributed over the whole length of the pipe, but the double tack work, as illustrated at E F G H, Fig. 437, only supports the pipe in two places, thereby, practically speaking, leaving the centre of pipe unsupported. As far as regards the appearance of these tacks, the pipes being

fixed against a wall, of course the pair tack work has the advantage.

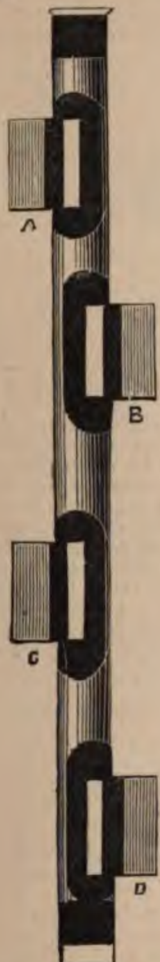


Fig. 436.

Fig. 437.

Twin Tacks.

This kind of tack is as the word implies, and should not be named as double tack, because one is led to understand that when a thing is double, it is twice the quantity, and

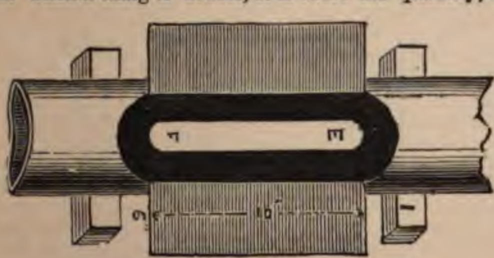


Fig. 438.

that it is to increase by an equal sum or value; this is not the case with this kind of tack, which may be reasoned out, upon examination of the diagram. The twin ear or tack, as shown at Fig. 438, is used in places where the tarnish or soil is objected to upon the soil pipe. The method of cutting this tack out is as follows. Having determined the size, cut a slot central, as about from the letters E to F, and about 1½in. wide, then shave it about ¼in. each side. Shave the soil pipe to the required size, which may be obtained by scribing it to the size of the slot, and wipe it on as shown at E F.

Band Tacks.

There are certain situations where it will be impossible to get the soil pipes through after the ears are soldered on. It may also happen that an extra tack is required, for some unforeseen reason, after the pipe has been fixed. Under such circumstances, an ordinary tack will be useless, unless it can be wiped on the face side; but when this is impracticable, use a band tack as illustrated at Fig. 439. This is a stout piece of lead the usual length of a tack, in

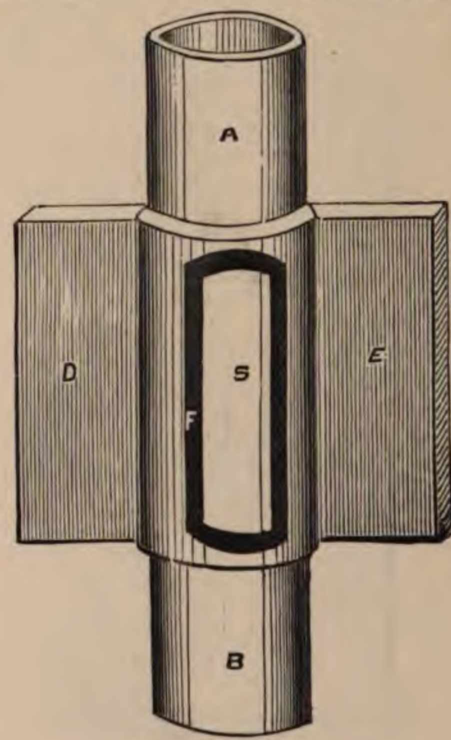


Fig. 439.

addition to that part bent round the front of the pipe, and soldered as at S F, in a similar manner as the twin tacks. The soiling, if objected to, may be washed off afterwards.

Pipe Socket Tacks.

This kind of tack is used where neither burning nor soldering can be employed, and for places where quantities of hot water have to pass through the pipes, causing sudden expansion and contraction, which would cripple and rip the pipes were they rigidly fixed with tacks or

joints. The method of making this for, say, an inch and half pipe, is as follows. Take a piece of 2in. pipe 3 inches long, and with the turnpin open one end to, say, $2\frac{1}{2}$ inches; then solder two ears *firmly* at the back of this socket, and this forms the socket tack. For fixing, push the end of the $1\frac{1}{2}$in. or other suitable pipe through the socket tack, and with your turnpin, which should be of the same cone as that with which you open the socket tack, open the end of your pipe to fit the cone of your socket, when you may fix your pipes in the usual way. You may turn the top edge of the pipe over the edge of the socket, and so form a flange or bead round the top part; or you may fix astragals, &c., around it and so make them ornamental. The length of these pipes should not exceed five or six feet; if for very hot water, not more than three feet. I have used these sockets for outside soil pipe work where there are no windows and where the south sun is very powerful.

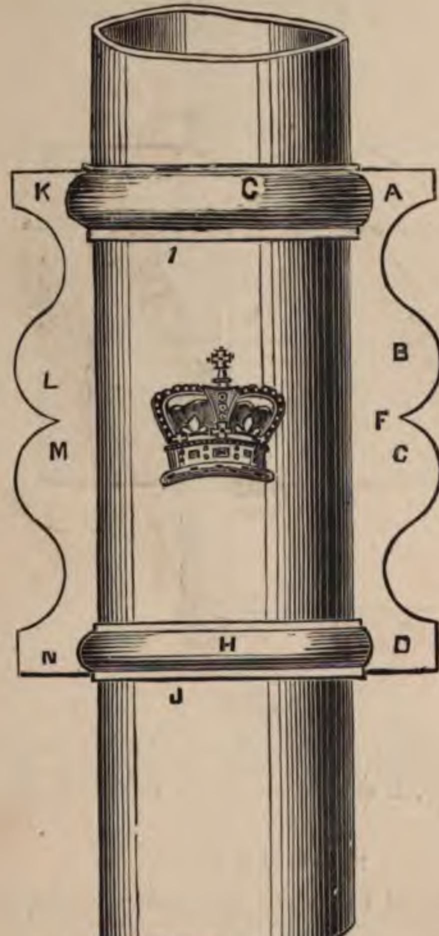


Fig 440.

Fig. 440A illustrates a very useful cast lead socket with astragals and ears, which, within the last two years has been enormously used, especially in connection with soil. waste or hot-water work, and answers the purpose of Fig.

Fig. 440A.

Fig. 440B.

440. But the method generally adopted in fixing this is as shown at Fig. 440B (which does not show the ears). It is fixed very simply and neatly by copper bit work, viz., the socket is first bitted on to the pipe, then the spigot end of the next or entering pipe is made to enter somewhat tightly into the socket, and well sweated round with solder.

Of course this soldering may be done by a neat workman with the pot and coarse solder, known as secret joint wiping, but the plan adopted in my works is to burn the socket on to six-feet lengths of lead pipe, and send them out similar to the well-known lengths of iron rain-water pipe, which they are made to imitate, though, perhaps, we may be by some considered to be retrogressing.

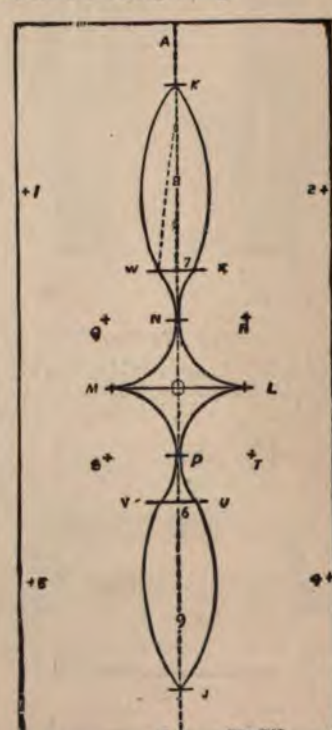


Fig. 441.

Ornamental Tacks.

These may be formed in various ways, but the following is the one generally adopted. [See A B C, Fig. 440.] This is nothing more than a piece cut out of the tack, with curves formed in such a manner as to produce an agreeable impression upon the eye.

Fig. 440 illustrates the finished ears, A B, K N ornamented, and Fig. 442 illustrates the figure work before the tack is folded up or turned back. E F G H, folds back upon A B C D, and hides the heads of the wall-hooks,

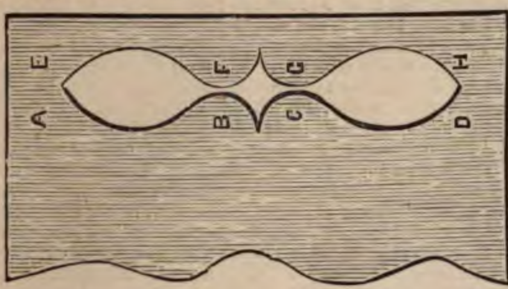


FIG. 442.

&c. While on this subject, it would be quite as well to give a full-sized geometrical method of lining out the tack in question, as nothing is worse than bad taste or want of skill in ornamentation; for if not done according to the rules of art, it had better be left undone. I have seen within this last week not a little of this bad taste displayed. I have here worked out a simple method which will be found easy to execute, and pleasing to the eye of those well versed in the matter. Suppose you require a tack for soil pipe work, in order that the ornament, so far as regards shape, be perfectly true, take a piece of lead the size required, say 8in. by 6in., as shown at Fig. 441. Draw the dotted line, A D, exactly where the tack is required to be turned from the outside edge as at A, set down ½in. or ¾in., as also at the bottom at D, and draw the line J K. Next divide the space between these lines into two equal parts, as at L, and draw the line L M square to the dotted line K J; next with the radius of D J—that is to say, ¾in., or whatever it may be—with O (in the centre of the figure) as the centre; strike the small distant arcs, M L P N. Across the lines, A D and M L, and from these arcs as centres, with the same radius as before, strike the intersecting arcs, Q R S T; and from these arcs, taking T as a centre, strike the arc, L P, carrying it on to about U, or further; also, with S as a centre, strike the arc, M V; then from Q as a centre, strike the arc, M N W, and also from R as a centre strike the arc L N X. Now, divide P N into three equal parts. Take one of these parts, and from P, strike the line, V U; also, from N, strike the line, W X, square to the line J K, cutting the arcs, L X W M M V U L; then with a radius of the points K W, shown by the dotted line in the top part of the diagram, set the compasses, and from the point W, strike the intersecting point 2, and from the point K, also strike the other part of the intersecting point 2, and from K as a centre, strike the intersecting point 1, also, from the intersecting point X strike the other part of the intersecting point 1. After this, with the radius of J U—or in this case, the same radius as before from J U, as centres, strike the intersecting point 3, and from V and J, as centres, strike the intersecting point 4; next, from the intersecting point 1, with the same radius, strike the arc K X, cutting the smaller arc X L at the point of contact, as at 7.

Next, from the point at 2, with the same radius, strike the arc K W, also cutting the smaller arc at W. With, as before, proper points of contact, do likewise from the centres 3 and 4. Next, cut out the central part O, then the parts 8 and 9, being careful *not to cut across* P or N, as shown at B F, C G, Fig. 442, because this holds the tack together in the same manner as D A does. After the tack is turned, work the circle P and N round the proper sweep.

When bending back these ears, be sure you bend them truly, and the effect will be perfect. To see the effect of this pattern, place a piece of paper or card over the one side, and up to the line, A B, You will now be able to see the shape as it will appear when folded back. Cover the side, K P J. This will allow the side of N D to be seen.

Sometimes it will be desirable to have the point M, Fig. 441, in the pattern as at E, Fig. 447, instead of being as at F, Fig. 440; in this case, the point M, Fig. 441, will be external, the effect of which may be seen by laying a piece of paper upon the line A D and over the right hand side of Fig. 441. Here the line will be seen of the tack as from A W N M V D, which part in the figure when cut out will be waste lead; the part on the right hand side being the required lead for the tack.

In this case, the parts O, 8, 9 of the pattern must remain in, and the line K X L P U J, not cut. When such is the case, the ear will not fold, and therefore two pieces must be cut the proper size; the ornamented edges are

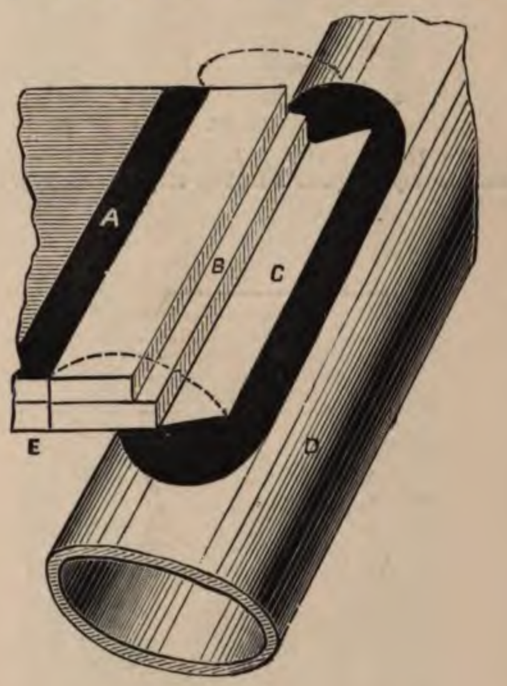


FIG. 443.

placed together and soldered as one joint to the soil pipe. Let the back or nailing piece, A, Fig. 443, be ⅜in. narrower than the front B, so that the front will support the back whilst soldering on, and in such a manner that the solder will have a good hold upon both tacks. Such joints must be wiped full and with a round back, as shown by the dotted lines.

I may add that the method of striking this is entirely original, as also the design, Fig. 440.

Astragals.

These are small mouldings of a semi-circular section with a fillet above and below; the cored section is plainly illus-

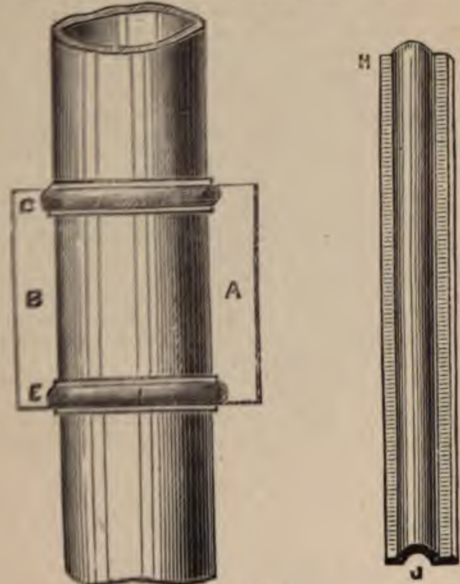


Fig. 444.

trated at H J, Fig. 444. It is also shown properly fixed round the top of pipe at G H, Fig. 440, and at E, Fig. 444.

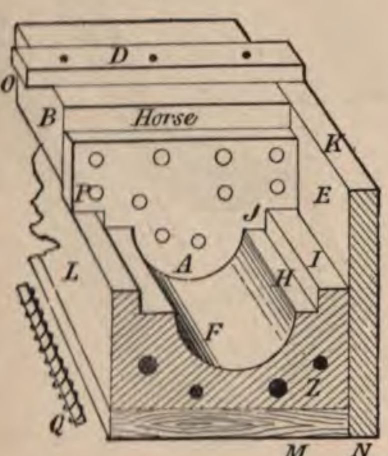


Fig. 445.

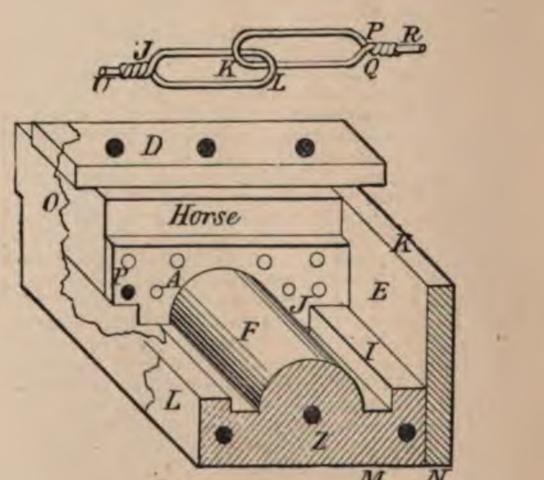


Fig. 446.

These astragals may be formed out of a piece of $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, or 1in. lead pipe, and the fillet worked on them. But the proper method of making them is to cast them in an iron shut-up mould, similar to the window lead mould [see Fig. 20], or when this cannot be had, get a mason to cut a mould out of soft stone, or get a carpenter to make a pattern, and cast it, face downwards, in soft loamy sand; or, if you cannot manage to get anything of this kind, get a plasterer to make you a suitable mould; any good man will do this. But if you cannot get assistance, then do the job yourself as follows:—Make a long wooden box in the shape of a trough to the required size and depth as shown at the part sections, Figs. 445 and 446. Say that the stand-up sides N are 4in., the width of the box, 3in.; screw the sides on to the bottom, so that they can be removed; now, make a horse to any size that may be required; the one side of the horse must be long to guide the mould plate A J truly along, and in a line with the trough; put a couple of pieces of wood, as at D, on the top to prevent it dropping too far into the box. Here the sides of the box answer as the shafts in the lead casting frame at Fig. 12. Next, settle upon the size of your mould for the astragal: say that the mould A J, Fig. 445, is just what you require; if so, and having cut your pattern from a piece of 4 lb. or 5 lb. lead (some cut it out of zinc, but lead will do if the plaster is worked soft), nail it on so that its lower edge will stand $\frac{1}{8}$in. or $\frac{1}{4}$in. below the bottom edge of the horse board, which should be about $\frac{3}{4}$in. thick. The sides or guides may be made of anything, and nailed on just to keep the horse board in a line. Now mix some plaster of Paris and whitening, say half and half, to a softish consistency; the whitening is to stop it from setting too quickly, or, better still, use some plasterer's putty (slacked lime. Make enough to fill up your trough to the required level, and bank up the ends just sufficient to allow the horse to work over, and work the horse in such a manner that the mould will plough away all the surplus plaster; keep passing the horse over the plaster some dozen or so times, occasionally placing a little very soft plaster on the part, which may be not quite smooth or even. Having the mould run, let it set thoroughly before you remove it from the box, which is done by unscrewing the sides; then let the mould stand by the fire to get thoroughly dry; but it must be dried slowly. Of course, in this manner you may make any kind of smooth moulding. The Fig. 446

represents the mould made the reverse of that shown at Fig. 445; one being raised, the other hollow.

Should you require a ribbed bead on your astragal as at A, Fig. 452, then you must have it carved or modelled. Having dried your mould, next block up the ends to the top fillet with bits of lead or otherwise, then fix it perfectly level, and run the mould full of hot lead. The lead should be run very quickly in order that it may set evenly, and without "cold shot," which will appear flaky.

Should you require many of these astragals, you may have an iron mould cast from your plaster one; or you may make one just the reverse to what you want, as at Fig. 446, then take the plaster out of the box and bank up the sides, say 1in. higher, and run a pot of lead over the plaster mould; then, when set, take off the lead and you will at once have a leaden mould, which being well "soiled" will work well for running hundreds of astragals. Of course when running lead in open moulds you must always keep the mould quite level. These astragals may be cast in the flasks, to any shape or size. The flasks are shown at Fig. 15, &c.

The method of fixing astragals round the pipe is by bending them round, and soldering them at the back with the copper bit. The chief object or use of the astragal in this class of rainwater or soil pipe work is to hide the joint; for strengthening purposes it is next to useless. But the astragal round the barrel of a pump, or the mouth of a cannon, is used for quite another purpose, namely, for strength.

Astragal Joint.

This joint is made in many different ways. The simpler method is to fix an astragal round the top, as at G, Fig 440;

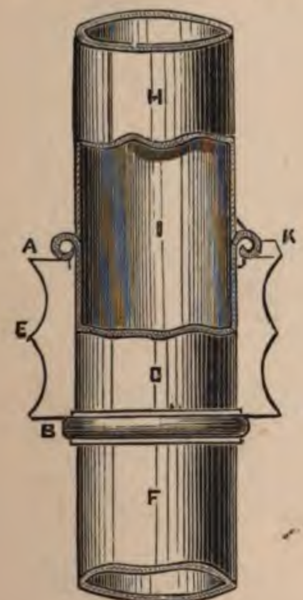


Fig. 447.

clean it thoroughly, as also ½ in. of the pipe, and let the top length be shaved ¾ in. up, out of which let it enter the bottom length ½ in., leaving ½ in. for solder, which should be wiped bare or copper bitted round the top part of the pipe, also to the top of the astragal—in fact, it is a kind of light flange joint specially made as a secret joint. Another method of making this joint is by turning a bead on the top of the pipe as at A, Fig. 447, and by fixing a narrow band of lead below. The bottom astragal B may be fixed as in the ordinary way. These tacks should be soldered on double as in Fig. 443, and have a flap K on the top of the back tack for turning down over the top edge of the front tack. This keeps the tack together and also prevents the water from getting at the wall hooks. By having a flap at the bottom, it answers as a "bale tack," and holds the front tack well together.

Ornamental Soil and Rain Water Pipes.

See the old pipes about London and other old cities, plenty of which have been fixed from 300 to 500 years, and as good now as the day they were first made. It is simply ridiculous for the architect to fix such as iron pipe to buildings that are required to keep in order for a century or two, when he well knows that the longest he can expect such to last is from 10 to 20, or at most 30 years; and even during this time it requires twice the original amount of money laid out upon it by way of paint and repairs, especially by reason of the sockets getting broken by oxidation, which swells with force enough to break them were they ten times the thickness. The sockets are also broken in times of frost by reason of the water getting into the joints and there freezing

Fig. 448 shows two lengths of rain water pipe. It is made after the manner of making soil pipe, but is made in

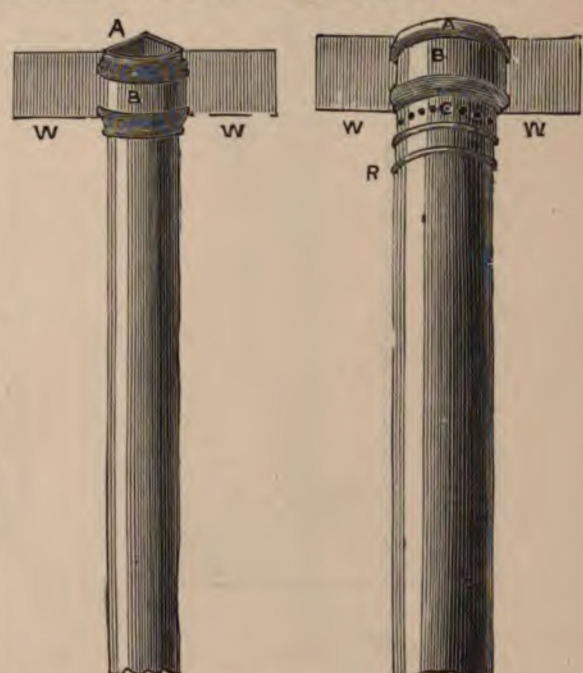


Fig. 448.

6 or at most 7 ft. lengths, having very strong ears or tacks, or at least half as heavy again as the pipe lead, and soldered on as at W W. The length of these tacks should be cut double the diameter of the pipe, so that two wall hooks may

be driven into two courses of brickwork, viz., two joints and the end to turn back over the head of the hook. [Also see Fig. 431, &c.] The top of the length should always have two good astragals fixed thereon, one within $\frac{1}{2}$ in. of top, the other the diameter and half to two diameters of the pipe away. [Also see H Fig. 440, and I, Fig. 444.] You may fix a bead or two also round the top, and decorate it as you like. A few $\frac{3}{4}$ in. balls look very well, and give a nice finish. [See W W, Fig. 448.]

Sometimes the back of these pipes are made triangular to fit into the angles of walls.

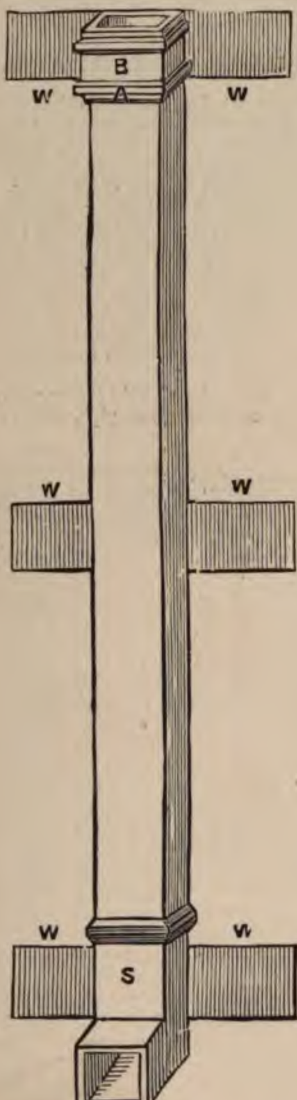


FIG. 449.

FIG. 450.

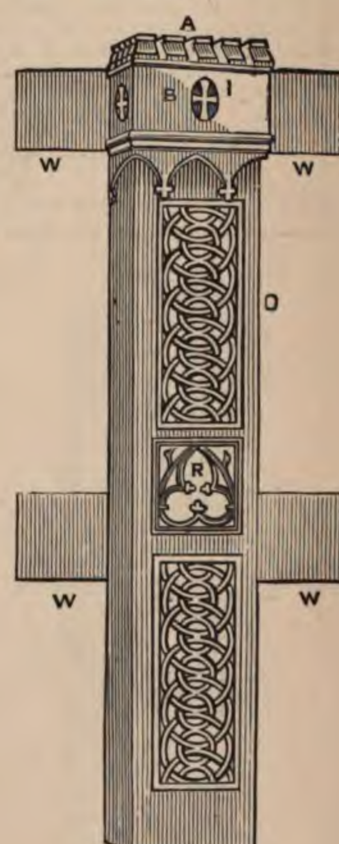


FIG 451.

Hints as to Ornamentation in Rain Water Pipes and Heads

These ornamental rain water pipes can be and are made to any design, and nearly every plumber and architect has his own ideas of ornamentation. Some will have the pipes made to a floral design, whilst others go in for geometrical work, but for my part, I think that the design shown at Fig. 440, has a good and neat appearance, and nothing better can be desired.

Of course rain water pipes, like guttering, should be fixed in accordance with the design of the building, viz., round or square, &c., but even with square pipes the design may be made neat, and to harmonize with the building. I have seen rain water pipes made and fixed which had by far too much ornament, and which is imposing and hurtful to the architecture of the building; therefore the plumber should guard against such discrepancy.

I have on many occasions seen rain water pipes made and fixed which totally disagreed with the rain water head. This is exceedingly bad taste. Fancy a floral pattern rain water pipe fixed under a geometrical patterned head. Then, again, I have often seen such things as Gothic rain water heads fixed near Corinthian or Composite Caps, and such like, and it is this class of work which I particularly wish my reader to guard against; and if you do not know, seek the advice of the architect, who will always tell you what to fix.

Square Pipes.

Fig. 449 is a square rain-water pipe. It is made on a square mandrel with the joint in the centre of the back, or

sometimes in one angle. The socket end may be cast or the pipe made wider here, and astragals fixed as shown. I have here fixed a shoe at bottom, directions for cutting which will be shown in the plumber's geometry. It is now high time you could make this without any further explanation.

Fig. 450 shows a lead rain-water pipe in the shape of a twist. The socket is also cast and soldered up, and put to-

should be in one piece of sufficient strength. Put an extra pair of tacks in the centre, as shown at W W.

Sometimes you may place middle tacks, as at Fig. 451, in the centre of a pipe. These tacks are made in the usual manner, and astragals may be soldered on the middle of the pipes.

Fig. 452 is made the same as Fig. 451. This is cast in

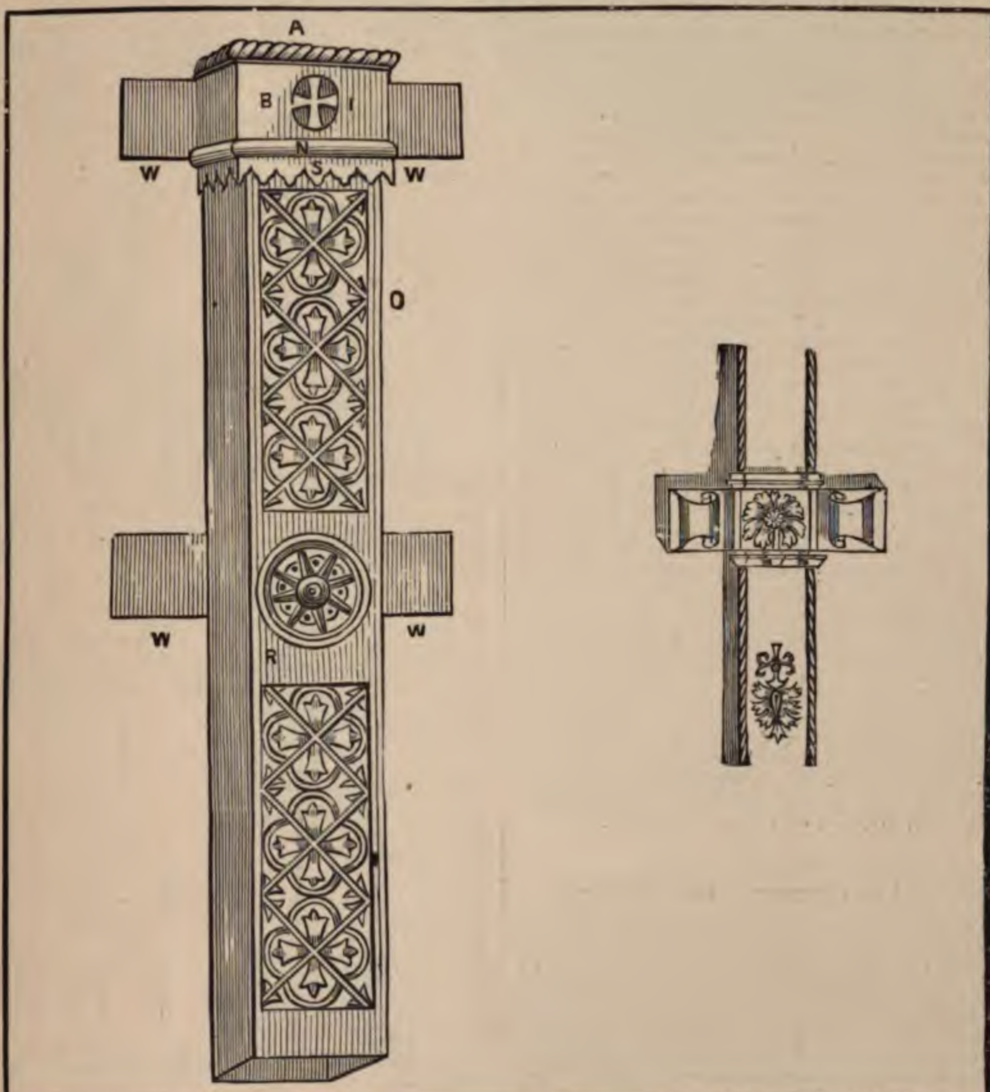


FIG. 452.

gether afterwards, with a seam up the back; or the pipe and socket may be cast, and in one piece, as moulders cast iron pipes, &c.

Fig. 451 is a cast front soldered on the two sides, or the sides and front and back may be in one piece, and bent round a square mandrel afterwards. The top is cast in four pieces, and joined together by solder; the back and wings

one piece, of course, from a pattern having a core box for making the core, or the core may be made by hand upon a rod of iron; but, of course, the core box is best.

This length of pipe may be made by casting the ornamental part face downwards upon the frame Fig. 12, and then by making it into a square pipe afterwards. For Heads, see Roof Work, next volume; also for Iron Pipe

and Fixing, and also see Town Water Supply, Street Mains, &c.

Soil Trap and Waste Pipe Planning, Fixing, &c.

Here I intend to describe the planning and fixing of soil or waste pipes and traps as practised by myself generally, and to give my reasons for carrying out the work in the manner specified. But before I proceed, I wish to say that you must guard against having a lot of unnecessary pipes; neither should they be out of proportion in size, nor laid exposed to frost, or in a roundabout manner, nor too deep in the ground, say not below 2ft. 6in. Always let them be fixed where possible so that they may drain themselves empty. Simplicity in number, straightness of route, and a judicious selection of material, are to be considered as much as any other points in plumbing.

Before I speak of fixing the pipes, I wish to draw your particular attention to the diagrams Fig. 339 and Fig. 340, also Figs. 354, 458, 472, 473, &c., for here may be seen a complete system of pipe work. Then let us examine Fig. 396. Here at T, 31, may be seen one way of connecting the soil pipe with the drain, and is so fixed that a clearing eye [see CLEARING EYE] is formed at the bottom, so as to enable you to make examinations when required; but it may be objected to that the soil pipe enters the drain on the square, and although working on the square is the best constitution in the world, yet it does not always do in the matters such as shown at the bottom of this soil pipe. This being so, let us see something else. Turn to Fig. 397; at F may be seen a bend to receive the end of the soil pipe, which will answer every purpose. Now, having seen that you can take the soil pipe into the drain in more ways than one, let me once more draw your attention to the matter of making your connection properly with the drain pipe, and ask you to be careful not to have a repetition of the disgraceful state of things as depicted at Fig. 425.

The first length of soil pipe being all ready for fixing with tacks soldered on, and the one end prepared, and, if necessary, tinned for making the joint above, let us now see about fixing it. First, with your chalk line, snap a line just where your one outside edge will come, and when fixing the pipe see that it is fixed in a true line with the chalk line; use the heel of a small square placed in the wall and on the chalk line, with the tongue standing up to the pipe, as at W X, Fig. 469, to try your work. Let us now see how it should appear when it is fixed. For this turn to Figs. 472, 458, 473, 474, 566, 565, 572, and 573.

Jointing Lead to Stoneware, Iron Pipes, etc.

There are many methods of doing this, many of which are equally good; but the one which I generally adopt is that shown at V E D, Fig. 453, which may be understood from the following:—Suppose Z to be a 4in. junction pipe, V the lead pipe, on the bottom of which is turned a flange to fit the socket E; now just place a small piece of rag or paper, not more than ¼in. thick, as shown by the black line D, into the bottom of the socket, and ram it there. Then fill the socket up with good Portland or Roman cement, let the joint set, and it will be all right. If you can make sure that the lead pipe absolutely fits the bottom of the socket, there will be no necessity for the paper; or by knocking in the end of the pipe, so as to enter the pipe part of the bend, there will be no necessity for the flange; but the flange is best, because in this case the pipe cannot sink to loosen the joint after it is made. Sometimes it will be necessary to connect the lead pipe with iron, and the cement joint will be often found good enough for this purpose—viz., in soil-pipe work; or at other times red-lead putty is used; other times resin and brickdust in equal proportions; at other times resin and mutton suet poured on to the joint,

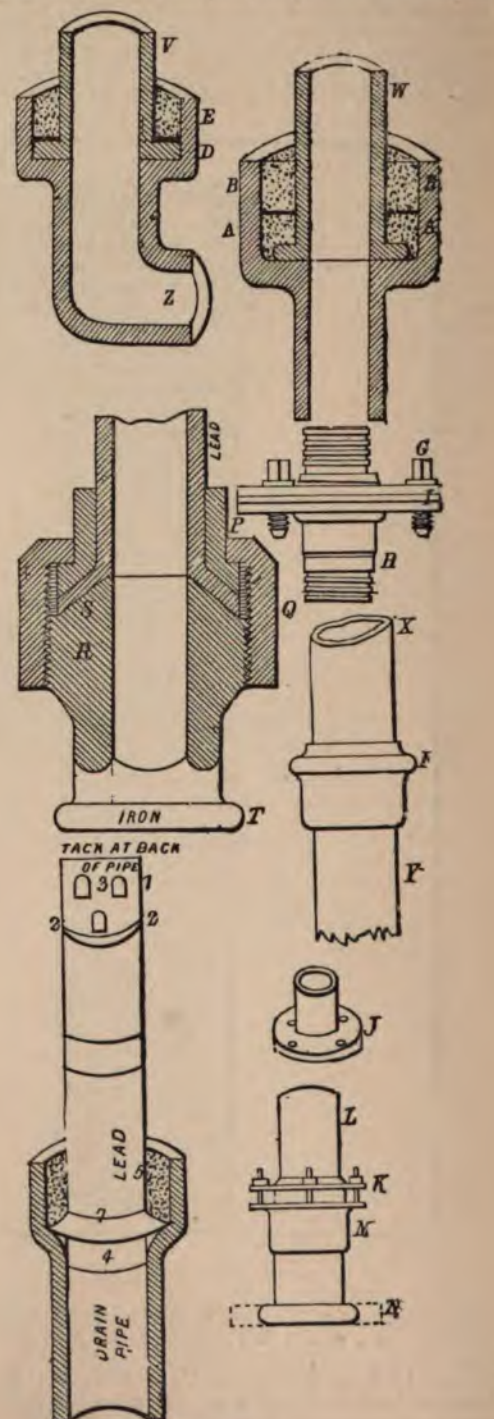


Fig. 453.

after it is stuffed with tow, spunyarn, etc.; other times the joint is run with melted brimstone with, and sometimes without, a little brickdust; at other times the joints are made as at P Q R S T, T being the spigot end of the union, which is run with lead into the socket part of the pipe. The top of the spigot end, as at S, is turned for the soil-pipe to be flanged upon, as at S, when the lot is screwed together, as shown in this figure; should the joint be unsound, a leakage must show itself. At other times the joint is wiped on to a flange, as at J, or as at G, and put together with screws; at other times the pipe is put together with a stuffing-box connection, as at L K M N, and also may be put together as at W A B, also as shown at X F Y. In fact, there are many other ways besides these shown; but those described are universally acknowledged. For my part, I very rarely use anything different to that shown at V E D or G I H. The socket 4, 5, 7 illustrates a very good method for making the joint, because the socket-part, 4, enters the drain-pipe, whilst the wiped flange, 7, supports the lead joint. This lead pipe is also shown fixed with secret tacks at the back. Assume that B, Fig. 472, is the bottom length made good with Portland cement to the drain (the drain pipe joint should not be made good until the soil pipes are all fixed, nor should the drain pipe be fixed permanently until the plumber has completed his pipe fixing, which allows him to take out any bits of stuff which may fall down the pipes when the work is about); of course this length may be 10ft. or otherwise; say that it is as at N Q M, Fig. 474. Here the tacks are shown as at M Q S, and now we must consider the making of the first joint, which, after what I have said on joint making, will not require to be repeated. But here is something more to be explained. It is as to how you are to get behind the pipe to make your joint. Suppose the pipe to be fixed upon the flat wall, as at Fig. 474, then do not fasten the tacks Q nor M, but let the pipe hang on the bottom tack, or otherwise. You can support it with a piece of sash cord, &c., &c. Pull the top part of the pipe out from the wall, say 3in. or 4in., which will allow you sufficient room to get behind to wipe the joint; but suppose you cannot pull the pipe out, then you must go differently to work. Examine the brickwork at the first joint in Fig. 472. Here you see the centre of the joint comes just in the centre of a brick. First with paper stuff up the end of your pipe to keep the rubbish out, then cut this brick out, also the one above and the one below. Cut the bricks back from the sides of the pipe a sufficient distance to get comfortably at your work. But perhaps you will not be allowed to cut the wall, and you cannot move the pipe forward, as in some cases on grand staircases, then you must make your joint as shown at Figs. 126 and 127. Now, having done this, get the next length, which, we will say, has been properly prepared and the end made to enter the one fixed, say about one inch, and with a length of sash cord, as at Fig. 454, which is tied with half hitches, &c., and in such a manner that it will not bruise the pipe, and as shown at 1, 2, 3, 4, 5, 6, 7, &c. Then pull the pipe up with the end of the cord 1 and place the pipe in a line with the first fixed length. Now with some fixing chisels, as shown at the fixed joint, Fig. 115, securely fasten the pipe so that it cannot move nor fall lower down into the bottom length

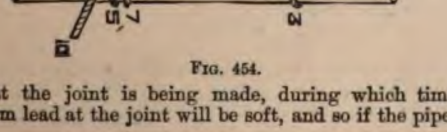


FIG. 454.

whilst the joint is being made, during which time the bottom lead at the joint will be soft, and so if the pipe from above is pressing upon this bottom length it will be apt to open and so allow the top pipe to sink. Having the lead pipes fixed, fix a collar, as shown at the joint F G, Fig. 125, and wipe the joint, as at Fig. 125 [see description], and as finished at 122; then place the pipe in a line with your chalk line and fasten the tacks on the bottom length to the wall, as shown at M Q, Fig. 474, and as many as you can, at the same time having regard to the pulling out the top end of the pipe for making the next joint. So far you can go on fixing your pipe until further orders, but as you proceed you must work in your branches, traps, &c., as shown at 35 and 37, Fig. 339, also at TRAP, Fig. 340, Fig. 353, Figs. 354, 473, &c. You should take particular notice of all these drawings, as they are exceedingly good and original, and point out many different styles of work from which much may be learnt. You should also glance over the diagrams showing the method of setting the work out, which are drawn from work actually done by the author between the years 1857 and 1882.

NOTICE.—I should recommend you to make rough book drawings of every job you do; it need not take many minutes, but it will be always very handy for reference, and from which you will be able to improve as you go on. This is very important to the plumber for reference, for what is worse than being asked as to what you have fixed here or there during the term say from three to 18 years after your work is done, and not being able to reply satisfactorily. It may be said that you personally may never see the job again after you have finished it. This is a very easy get out, but, on the other hand, you may. I will tell you something about this careful class of work. When I was doing some extensive alterations in the plumbing work at the London Central District Schools, Hanwell, I, as was my usual practice, made rough drawings of the run of the pipes, &c., and went away, leaving my employer. About five years after this I received a letter from the same builder, Mr. Strudwick, of Ealing, stating that the architect required to know all about my work at the schools. I went to Mr. Strudwick and from my book pointed out everything required. For this the architect gave me £5, and Mr. Strudwick gave me the foremanship of plumber's work upon the new wing which was built just afterwards; and I can safely say that through acting as I have in the way of making rough drawings, that it has saved me scores and scores of pounds since being a master plumber. I trust that these hints will be useful to my apprentice reader, and there is no question that his drawings will.

Position for Closet Traps.

Before fixing a trap for a water closet, you should ascertain the description of apparatus it is advisable to use, and broadly speaking, a valve closet is the best, Bramah's principle. For a valve closet the distance from the wall, A, Fig. 455, to the centre of the trap-dip should be 14in. Speaking generally, closets are very narrow, frequently not more than 3ft. wide—6ft. is considered a barn of a closet. When the closet is from 3ft. to 4ft. wide, the trap should be fixed 1in. out of the centre to the right, as shown at 17in., or between B and E. This is to allow the handle and dish of the closet to come within the flap of the closet seat. This also applies to pan-closets; but for the pan-closet the distance from the back wall, A, to the centre of the dip should be only from 12½in. to 13in.

For Jennings' Closet, and some other special makers, you will find it necessary to examine the outgoes and trunks, and so ascertain the proper distances. I will give the exact distances for those best known in the market.

Fig. 155 plainly illustrates the method of trimming the joist for the trap. The trimmer, L G, carries the joist,

H I J. One end of this trimmer, in this case, has a bearing upon the brick wall at L, the other end is trimmed into the joist, K. The trap is supported upon two bearers, M N; and as can be seen, the ends of these bearers rest upon the brickwork; the other ends are trimmed into the

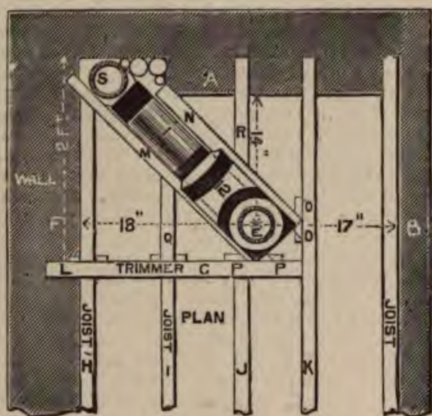


FIG. 455.

trimmer, or are sometimes made to rest on the fillet, as shown at O O, P P. Q and R are two bearers to support the boarding for the floor and closet-safe to rest upon, &c. This trimming is the general method adopted throughout England, and should be well noticed and remembered. The front TRIMMER should always be kept far enough back—say 22in.—from the back wall, as shown at L P P.

Twin Closets.

London builders are certainly very much to blame for not, when building houses, providing proper children's closets. I have fitted the whole of the closet and plumbing-work for some scores of builders, many of whom were and

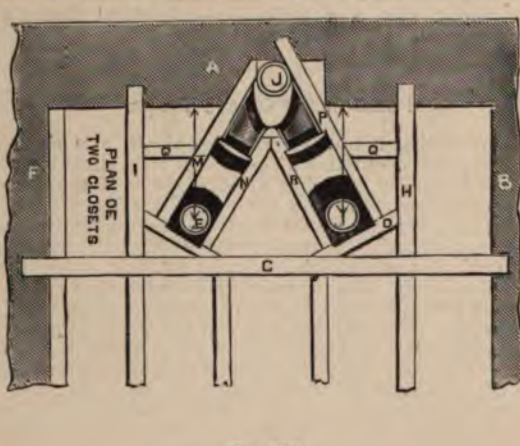


FIG. 456.

are in a large way of business, and only one man has consented to have children's closets fixed; and furthermore, to show how much this branch of the trade is neglected, I only know one out of the many dozens of closet-makers who make a valve-closet for juveniles—viz., Warner and Sons. Fig. 456 illustrates by plan the method of fixing the traps for twin-closets, and also the trimming of joists, &c. In closets having plenty of room, the traps may be fixed at equal distances from the side walls, E B; but where the closet is narrow, the small closet should be on the left-hand side and nearer to the wall; then the large closet-trap may be fixed the same distance from the back of the brickwork, as from E to A. The traps are trimmed in much about the same manner as in Fig. 455, excepting the end of the bearer, P, Fig. 456, which I have shown run into the brickwork, and is now in the way of fixing other pipes up the chase, but which may be supported by another shallow trimmer, Q, so fixed that it does not come in the way of the under-side of the soil-pipe, &c.

Fig. 457 illustrates the pipes passing through the wall as at S, it also shows the pipe fixed on the right hand side,

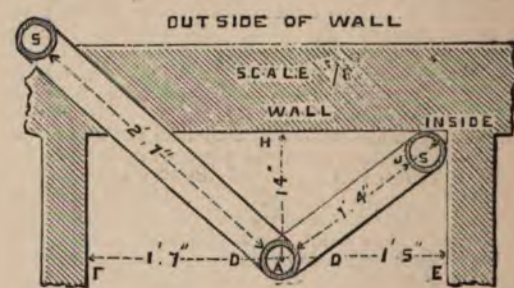


FIG. 457.

and going down the inside of the wall. It also illustrates the dip of trap A fixed 1ft. 4in. away from the back wall, and 2in. out of centre.

The sectional elevation Fig. 455 is shown at Fig. 458. S, the soil pipe; (1) the outgo of the trap to the soil pipe;

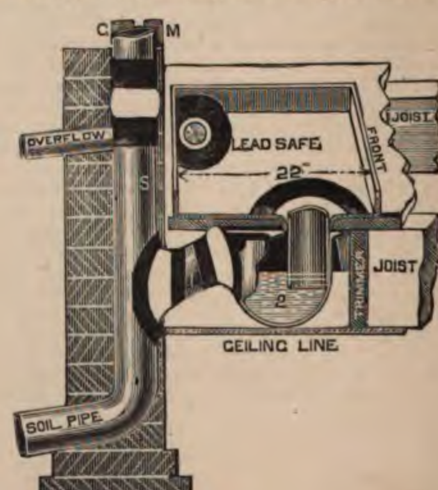


FIG. 458.

(2) the trap, which of course may be of any shape or make, and which I have said sufficient about in Traps. By the side of the soil-pipe are fixed the smaller pipes, that can only

be seen at the top near M and C, also in the plan Fig. 455 This Fig. 458 also illustrates the lead safe of the closet and overflow. The overflow should not go into the soil-pipe unless under very special circumstances, and then great care must be taken to ensure the trapping being thoroughly perfect, which will be spoken of hereafter. [See B E, Fig. 577]. Sometimes the safe overflow-pipe is soldered into the cheek or heel of the trap, as shown at B, Fig. 572, but this is not a good plan, only for temporary jobs, because these pipes in time become furred up, &c. The safe, which will be spoken of in detail, should be large enough to admit the closet, but not too large so as to protrude too far in front, and in such a manner that it will come in the way of the closet seat riser. It should never project beyond the front of the basin, which is generally 23in. from the back wall, so that 22in. will be plenty for the bottom of the safe to stand away from the wall, because the top can easily be bent over against the riser, if required.

The safe should be properly soldered down to the dip of the trap, and *sunk*, as at A B, Fig. 459, and D R, Fig. 481, in order to allow the solder to be wiped level or flat with the bottom of the safe.

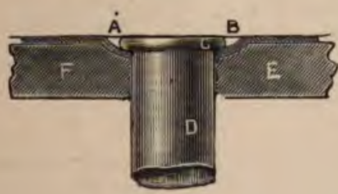


Fig. 459.

The angles of the safe may be soldered, bossed, or dog-eared up; the last-named will not have as neat an appearance as when bossed, but if properly done will answer every purpose. A dog-eared safe is shown at J H D, Fig. 482. L is the front of the safe; the corner B E, is to be turned towards B. For bossing up corners, &c., see my Roof Work, next volume.

It may be said that I should in this description show by an illustration what the closet is like when fixed, so that the reader might be better able to understand what is meant by the dip-pipe standing out too far, or not far enough; this being so, refer to the pan closet and basin, Fig. 461, also to the valve closets, Figs. 262, 265, 266, 573, &c.

For the pan closet basin, refer to Fig. 460.

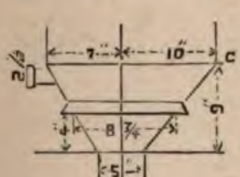


Fig. 460.

This is a drawing of a first-rate maker's pan closet basin. It may be seen that the front rim protrudes or overhangs from the centre line 3in. more than the back part, but this is rather an exception. The generality of basins overhang only 1½in., whilst badly-constructed basins are still less, and at times may be found with equal slopes back and front. Such basins (unless an extraordinary flush is given) will invariably be found dirty on the back slope, because the soil touches that part of the basin when dry, and is at times very difficult to wash off; whereas, on the other

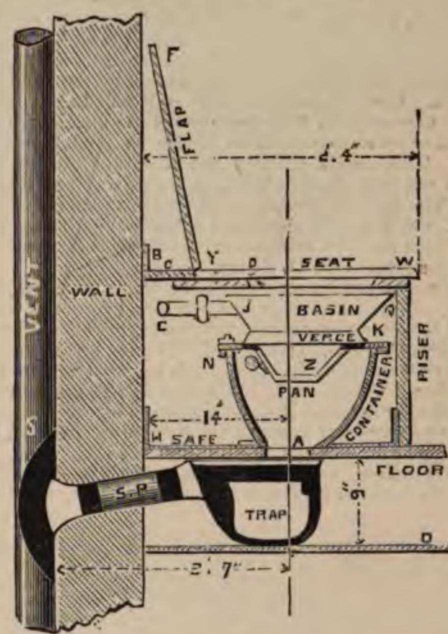


Fig. 461.

hand, if the basin is properly constructed, the soil falls direct into the water. For this see the closet and seat combined in the sectional elevation, Fig. 461, by which it will be seen it is almost impossible to soil the back part, by reason of its shape. There are two lines across the sectional lines at D, showing that even with this basin some carpenters who are well conversant with closet work will keep the back part of the closet seat well forward, which must, as a matter of course, prevent the back of the basin from getting soiled. Referring again to this diagram, it may be seen that the centre of the trap is fixed 14in.

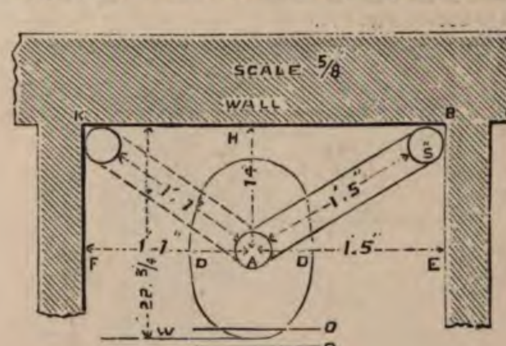


Fig. 462.

away from the back wall or brickwork, and that the front of the basin stands 2ft. 1in. from the wall, and consequently throws the front riser about 2ft. 2½in. from the wall. This is at least 1½in. too far forward, and especially when,

which is not unfrequently the case, the closet is cramped up for room; but this evil does not rest here. There is a still more valid reason for keeping the closet trap to its right position, viz.: when the closet seat is too far out from the brickwork, the flap, as shown at Y, will be fixed or made to lean too far back, and so be of little or no use for one of its intended purposes—that is, for resting the back against, a most desirable and exceedingly useful rest, especially for invalids. Under these circumstances it will be found best, if not necessary, to keep the front of the basins, whether for pan or valve closets, at as nearly as possible one distance. This should never exceed 23in., and, for my part, should not be more than 22in., as shown in Figs. 462 and 463. The latter represents the trap for a pan closet fixed 12½in., and Fig. 462, the trap for a valve closet fixed 14in. away from the back brickwork. The shapes of the basins are also shown at D, D, G, etc.

In the event of it being necessary to fix a valve closet over a trap that originally had been fixed for a pan closet, it will be found that the front of the basin will only reach to the line C, Fig. 463; but should, on the other hand, the case be *vice versa*, or in other words the reverse, the front of the basin would reach to the line Q, Fig. 462, unless the basin for a valve closet be of a larger size and the basin for the pan closet of an equal slope and of smaller size. This kind of basin can at any time be obtained.

The plumber, be he who he may, having decided the kind of apparatus it is most advisable to adopt, must first

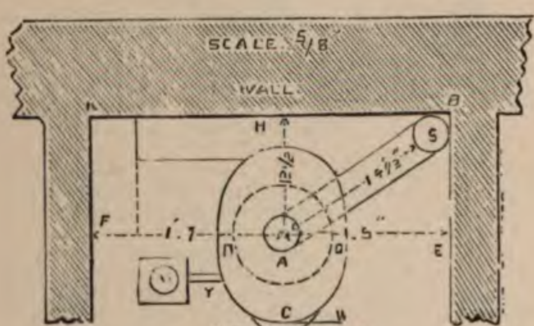


FIG. 463.

proceed to the fixing of the trap. This being so, I must ask you to assume Fig. 461 to be the closet, exactly like the one that has to be fixed, and let Fig. 457 be the plan. The

FIG. 464

elevation of Fig. 461 illustrates the fall and the outgo pipe S P, and Fig. 457 the distance between the dip and the soil pipe. I have here shown the plan for an ∽-trap and an elevation of a D-trap; if an elevation of an ∽-trap is required, see Fig. 465; and a plan of D-trap will be seen at Fig. 455.

Fixing Traps.

Now having fixed upon the distance for the dip from back and side wall, let the trap be trimmed into its place as shown at Fig. 464. This is done by the carpenter. If the trap be a half ∽, as shown at A B, Fig. 465, get the carpenter to nail a piece of board, say 9" wide, as at 10 and

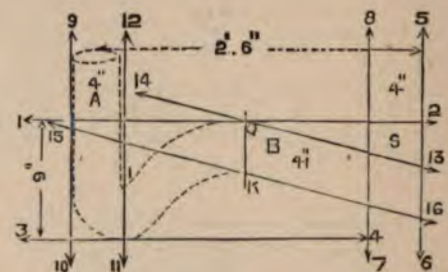


FIG. 465.

11, across the bottom of the bearers or trimmers of the trap. This will keep it up whilst you are taking your measurements, &c. I speak of this simply because there are no flanges to support this trap. Now, having the trap properly trimmed, proceed with a lath, or straightedge, or rule, to take the distance from the centre of the trap dip to the back of the brickwork, allowing for the soil-pipe not going quite back in the corner behind the soil-pipe at B, Fig. 463, &c.

The most advisable plan is to take a short length of the soil pipe and place it in the angle; then take the distance from the front of the pipe as at J, Fig. 466, to the centre of the trap (say this is 2ft 6in). Next is the fall; for this refer to Fig. 464; as a general rule it will be found that there is

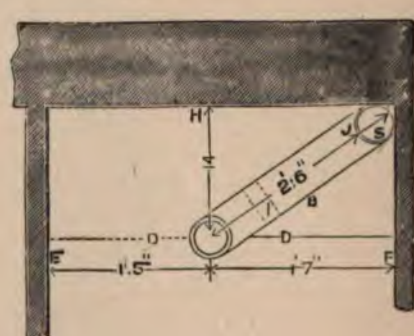


FIG. 466

a 9in. joist to work between as from the floor line R P, Fig. 467, to the ceiling line Q, so that there can be at least four inches fall in the short length between I and C, Fig. 468, without the outlet being below the ceiling, as shown at 23. [Also see 4 in Fig. 464 and Fig. 465.]

These distances being arranged, proceed to mark them on the floor or bench, as at Figs. 467 and 468, in the follow-

ing manner :—Firstly, with the chalk-line, snap the floor-line 1, 2, Fig. 468, afterwards the ceiling-line 3, 4, 9in. from the floor-line (that is, assuming it to be a 9in. joist),

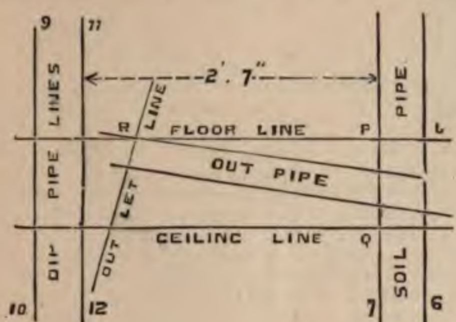


FIG. 467.

but if only a 7in. joist, the ceiling-line must be only 7in., and so on in proportion. Now, with the square, strike the back-line 5, 6, which must be square to the floor-line, be-

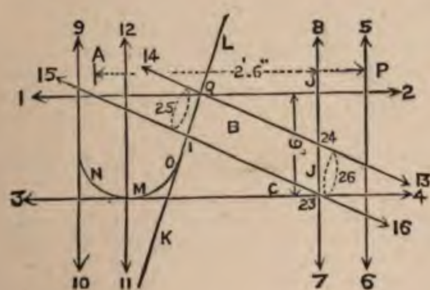


FIG. 468.

cause we are justified in assuming that the walls are thoroughly perpendicular and the floors horizontal; hence, the reason for the back-line being square to the floor-line. Now, assume the soil-pipe to be a 4in. pipe, $\frac{1}{4}$in. thick; strike the pipe-line 7, 8, $4\frac{1}{4}$in. away from the line 5, 6, and parallel to it. This done, you have the floor and ceiling-lines, as also the soil-pipe lines.

Next upon the floor line, set back the distance from the centre of the dip to the front of the soil pipe, when the soil pipe and dip are measured in a level line with the floor line, which I have already said is 2ft. 6in., as from A to J, Figs. 464 and 466; then mark $2\frac{1}{4}$in. each side of the point A, Fig. 468, as at 9, 12; this will be for the dip lines, 9, 10, 11, 12; draw these lines parallel to the wall or soil pipe lines and square to the floor lines.

Let me instil into your mind the necessity of thoroughly understanding what is meant by fixing your trap, the 1in. or so out of the centre for narrow closets. Fig. 466 illustrates the trap fixed on the wrong side, and is consequently 1ft. 7in. on the right hand side, and 1ft. 5in. on the left; therefore the dish of the pull is in the way of the flap rail, and just the reverse of what is required. [See Fig. 463.]

Fixing the Traps.

Take the trap and lay its top edge upon the floor line, as illustrated at Q Y, Figs. 469 and 470. Be assured that the top cheek lies level, which may be adjusted by placing a piece of $\frac{1}{2}$ in. or $\frac{3}{4}$ in. board R, Fig. 470, under the trap, sufficient to allow for the flange 18; then, to be quite certain that you have the exact length for the outgo, place the heel of a small square W X, Fig. 469, upon the dip-line, and adjust the dip of the trap to the blade of the square. This done, you may be quite positive that your lengths are accurate. Next, with a blacklead pencil (see V, 19, Fig. 470) held plumb with the band of the trap, mark round the outgo as shown. The outgo of all traps should be straight, as at

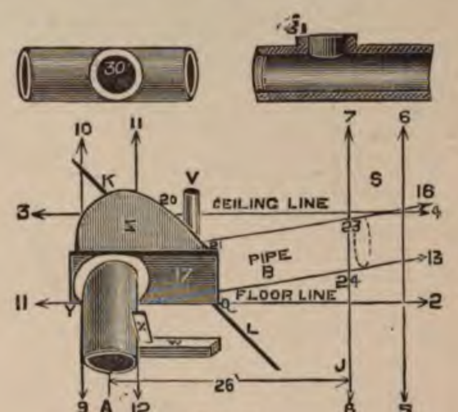


FIG. 469.

20 and 21, Fig. 469. Now take the trap away, and with the straightedge held to the straight part of the line marked, draw the line K L; this is your cutting line for the short length of pipe B, Fig. 469, K L, Fig. 468, OUTLET LINE, Fig. 467, 464, K Q, Fig. 465, &c., this done draw the pipe lines 13, 14, 15, 16, Fig 468, care being taken to get the proper points for the outlet of the trap as at Q I. Of course the points 23 and 24, Fig. 469, must be taken from the meeting point of the ceiling line with the pipe line,—that is, in cases where you wish to have all the fall you can get, but this is not always wanted. Perhaps half this fall will answer, as shown at Fig. 461, and at 4, Fig. 465. Now having these lines 13, 14, 15, 16, Fig. 468, lay the pipe as shown by the dotted lines 25 and 26 and 23 and 24, Fig. 468, upon the lines, using the square as you did with the dip pipe; or if it is a bend, as at 21, 24, 25,

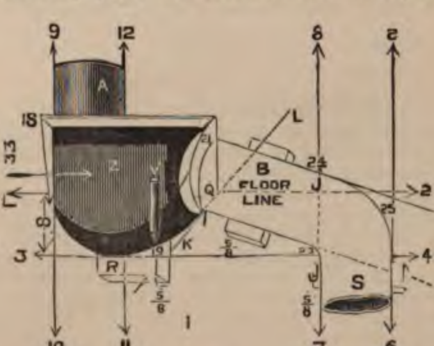


FIG. 470.

26, Fig. 470, do likewise; then with a saw held perfectly upright (a long panel saw is best) cut the lead pipe through, and true to the lines L K and 7, 8. This will be the exact

length for the outlet pipe, besides being cut true to suit both trap and pipe. Be sure and fix the pipe on to the trap exact as it was cut to the lines, which can be told when you tack it on, that is, when laying down as at Fig. 470. Open the pipe S, Fig. 464 or 469, to come up to a true round hole and face line for the branch pipe to enter, let the lead project ⅜ of an inch past the face to receive the branch pipe as at 30, and the section 31, Fig. 469.

I need not here explain the method of joint making, nor the preparation of it, but assume that my readers are already efficient in this branch, it being explained in the earlier part of this work.

Having everything soiled, lay the trap down in its place as before upon the floor line, and also the outgo pipe as fitted; then mark the trap for shaving, shave it if for a D-trap, partly as you would for a flange joint; if for an ∽-trap, as you would for a round joint, and again lay it down. Next, with a ladle half-full of solder, tack the trap to the outgo pipe, so as to fix it together. The tacking is done by simply splashing on sufficient solder to tin the joint in places as shown at 1 and 21, Fig. 471, leaving just sufficient solder to keep the work together. Pick the whole up, and fix it on its end in a position something like the illustration, Fig. 471. After the joint is wiped as at B, Fig. 464, lay it down again upon your lines, and *tack* the branch joint 23, 24, Fig. 469, when perfectly square; and be careful to block the pipes up to a level with the trap outgo, as shown at B, &c., Fig. 470; then pick up the trap, outgo

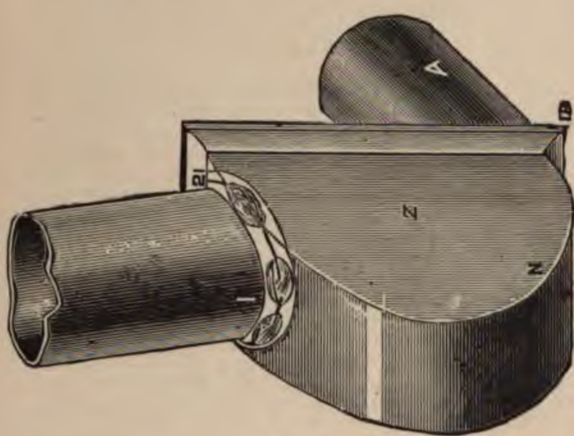


Fig. 471.

pipe, and soil pipe in such a manner that the soil pipe S will lie upon its back, as shown at P 6, Fig. 464. This position may be viewed by sighting vertically with the arrow, and along the arrow at 36, 37, Fig. 464. When the joint is made, if not already done, solder on your tacks for supporting the soil pipe; then fix it in its place.

Fig. 465 is an illustration showing the same method for fixing the half ∽-trap. The lines are all the same, excepting the outgo Q K, which must be struck straight across the the outgo and the outlet pipe. Cut to the line Q K as before; this joint may be made underhanded or upright.

After what has been described, the lines suitable for any kind of pipe work may be easily arrived at, and the main thing is to be careful about your measurements and points. Of course, if your half ∽-trap is a 4in. and has a 2in. dip you, must (if only 9in. joist) bring the outgo a little higher up, and fix it say ¼in. below the ceiling joist; the lather will manage to bend his laths a little to suit the work. If you cannot do this, just flatten the bottom, say, ¾in., and also the top; the trap will work, notwithstanding that you have slightly altered the bottom and top.

D-Traps in some Places must above all others be used.

It very frequently happens that when closets are fixed in such isolated positions *that no provision is made for ventilation.* Where this is the case great care must be taken that a good D-trap is fixed and made in such a manner that it is impossible to siphon it out. In all such cases the trap must be made according to my first method of making D-traps, *i.e.*, strike the cheek out as shown, *but make the band at least half as wide again as the dip:* thus, suppose the dip to be 4in. you must make the band 6in., as the reason why D and other traps siphon out is because the body is too narrow—that is, where the band is only the width of the dip. The consequence is, that all the water is driven out of the trap to allow the air to pass, and then this water is urged onward from the dip towards the outgo. N.B.—It is very seldom that any more water can be siphoned out of a D-trap than is contained within the dip itself; therefore, when the trap is wider than the dip, it is proportionately more difficult to lower the water below the dip; and if, on the other hand, the trap is made proportionately longer, the action will be pretty much the same, and it may be considered almost an impossibility to siphon it out. But while, by this system of making the D-trap, you, to a great extent, overcome the evil of non-ventilation, you meet with another serious difficulty—namely, that traps so made are not easy-cleansing to the extent they should be; but, nevertheless, it is the best method to adopt under the circumstances. The only other thing to be done is to have an ample supply of water to suit the circumstance and to properly cleanse them thoroughly every time there is occasion to take the closets up, and indeed it would be advisable for plumbers to make this a standing rule—never to refix a W.C. without cleansing the trap.

A man that cannot fix a closet which shall be thoroughly sound, stinkless, and siphon proof, whether it be of the valve kind or simple hopper without ventilation, is no plumber. The ventilating is especially for the protection of the materials used, and for allowing traps to be used which are of a smaller kind, and which are not proof against siphonage. A case has just come under my notice where several closets are required to be fitted up for 12 months or about; it is impossible to take a vent pipe above the closet; is this any reason why a closet shall not be fixed *temporarily,* or for the occasion?

Fixing Traps and Soil Pipes.

In some cases you will find it necessary to fix a soil pipe without a trap suitable for closets having traps as shown at J, Fig. 575, where the pipe is shown branched into the soil pipe; at other times only a short length will be required to be fixed as at L R, Fig. 576; this is suitable for a closet where lead soil pipes cannot be used, perhaps from a monetary point of view, &c. But this needs no further comment. We will now proceed with our soil pipe fixing with traps. Having explained the method of fitting the trap upon the soil pipes, it will be time to proceed with the fixing.

Suppose it is required to fix a closet trap on the first

floor as shown in the sectional elevation at D, Fig. 354, and that the soil pipe is to come down the outside as shown at M, F. On the same floor on which the closet is to be fixed, we shall require a bath, as shown at B. From this bath we shall require the *trapped* waste pipe (see trap) to come 6ft. or 8ft. down the outside, as shown at K, L. By bringing this pipe down the 6ft. or 8ft. your bath empties quickly, by reason of the induced current or draught; but notice, it will be imperative you do not under any con-

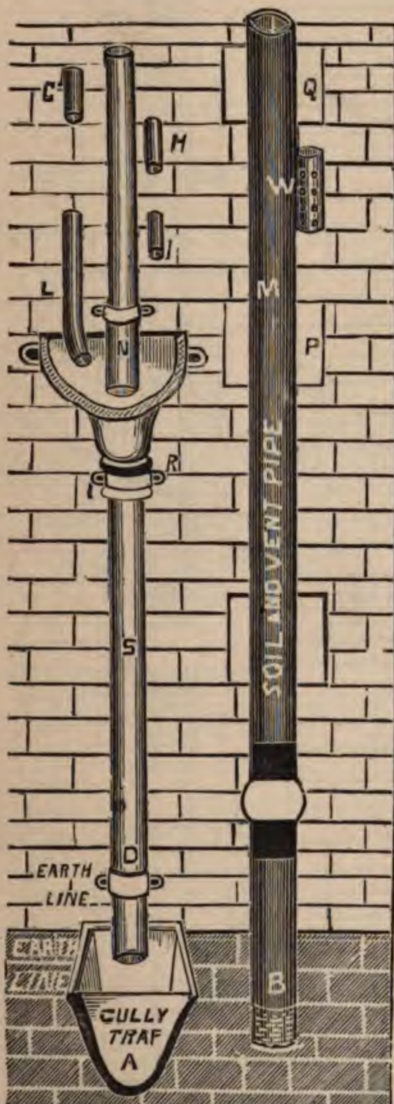


FIG. 472.

sideration branch a ventilating or any other pipe into this waste; if so, the draught will be interrupted, and when in action an unpleasant and gurgling sound will be made. Here a small ʊ-trap having at least 3in. dip must be made in order to prevent siphonage, or my bottle trap with, say, 4in. dip may be used with advantage. ᔕ-traps must not be used. There must be an overflow at C, or otherwise, and a waste pipe from the tray or safe of bath and W.C., as shown at H I; *but notice where the ends now terminate.* Here are all the waste pipes that are necessary for such a job, and now I want your attention, in order that you may see for yourself the advantages of this system. Turn to Fig. 472. This we will call an end elevation of the before-mentioned pipes, showing the arrangement of disconnection. M is the soil pipe, G the overflow from bath, H the waste from bath safe, I is the waste pipe from closet safe, N bath waste pipe, and W the vent pipe from the box of valve closet, *not shown in the section* Fig. 354, nor is it often fixed, only by Mr. R. Weaver, a well known sanitary engineer of the first standing.

Now, let us examine this system in a strictly sanitary point of view. The soil pipe goes down, and in this case, as shown at B, goes about 6in. below the earth and through the wall, and is with a Y junction, Fig. 405, branched into the drain pipe [see W, and at drain, Fig. 354] to answer as a ventilating pipe; but notice, there should be no trap between this and the intercepter trap [see elevation of drainage, Fig. 357], but let it be air-tight from the intercepter to the highest point of the roof, and terminate 8ft. or 10ft. above this level, as shown at 25, 26 and 27, Fig. 339. The soil pipe is shown in Fig. 357, by the dotted lines near Butler's S, K. Through the whole line of soil pipe and drainage, and from the inlet pipe at the top end of the intercepter trap, the fresh air is allowed to flow; but care must be taken to fix the fresh air inlet pipe in such a situation that if the current is reversed it cannot enter the bottom or other parts of the building, especially if air gratings abound around the basement. Make certain of this, for a return action is almost sure to take place some day, and when least expected. Great damage to health has been caused by this kind of thing, in consequence of the injudicious dabbling of many of the self-styled or so-called sanitary engineers. Therefore, let me impress upon you not to use this system unless you are perfectly safe and sure that a back current cannot take place, or that *the fresh air inlet is placed out of the building*, or away from under the windows, doors, air gratings, &c. I may here add, that in order to avoid the return of foul air from these vent pipes, light mica and other flaps have been used, and I, myself, have introduced very delicate action, mercurial and other fresh air inlet valves or flaps; but however good their mechanical action may appear at the time of fixing, they, at certain times, either act as retarders or become totally useless, and my experience teaches me that they should always be discarded.

Now, let us examine the waste pipes, and be careful what you do with this class of work, for I find more harm done by the injudicious use of disconnection than is generally known. Many think that because they have the ends of the pipe disconnected from a drain, that this is all that is required; but this is not the case. Disconnection is a point which will require your particular attention.

For this let us examine Fig. 473. Here we have a side elevation of two closet traps, bath, and wash basin. The pipes are arranged apparently in the same manner as those in Fig. 354, but with a wide difference. The bath waste pipe in Fig. 473 is not trapped. Now, turn to Fig. 474. Here all pipes, excepting the bath safe overflow pipe I, are brought to discharge into the bottom head, as shown at G P Q. The head-down pipe, S, is led to discharge over the mouth of a gully trap, as at A, Fig 354. This gully trap soon becomes coated with filth, as also the down pipe S, Fig. 473, and worse still, the water within the gully trap is at times stinking, and the fact is that the pipes above the head become flues, and so this stink is being drawn up the pipe S, and the open ends of the lead overflow

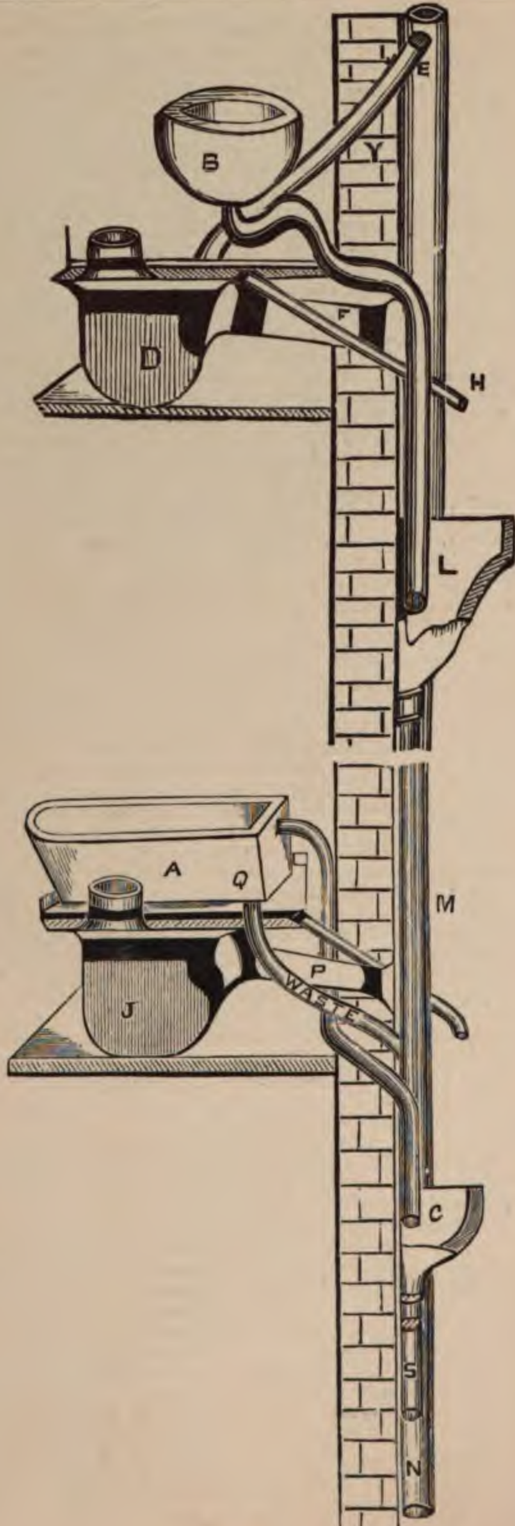


Fig. 473.

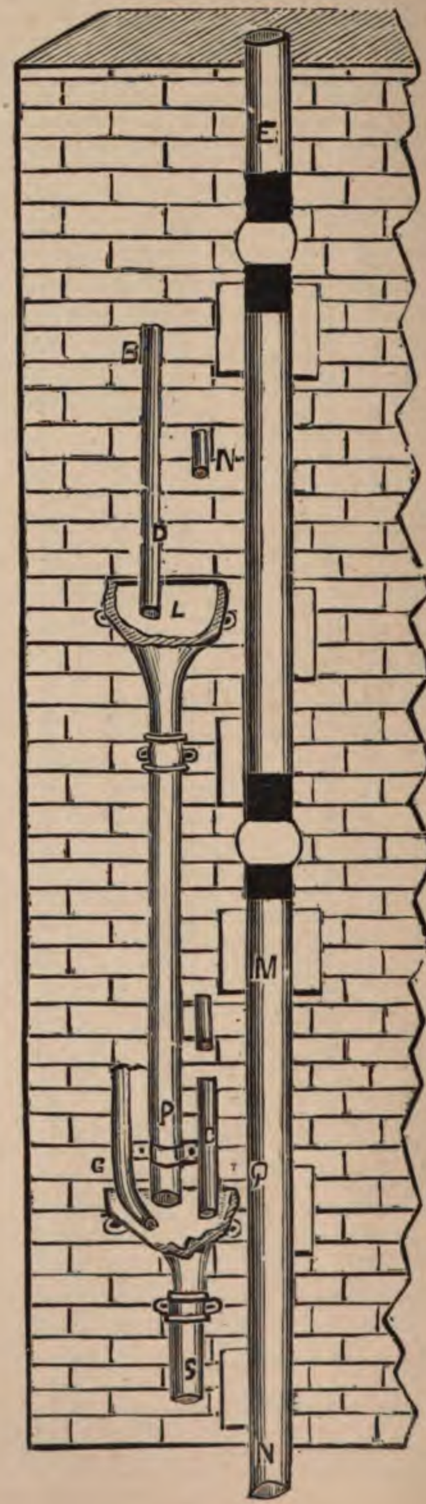


Fig. 474.

pipe C, &c., and is continually being conveyed into the bath, which stink often causes sore throats or diphtheria. All this may be easily altered by only allowing the trapped pipes to enter the head, as at L, Fig. 472. Let the *untrapped* overflow pipes be kept five or six feet away from the mouth of the head, but made to discharge plumb over the same, as shown. Then, should any unpleasant effluvia arise, it is a thousand chances to one but that it will become oxidized, or be carried clear away, and the whole arrangement will be better. Some people recommend flaps over the ends of their overflow pipes. I do not, for they often become set fast just at the time they are wanted to act, more especially in the winter. The above diagrams and descriptions will illustrate everything that is required to be done, so far as regards disconnection in sanitary plumbing, but ventilation of closet traps yet remains to be explained.

Ventilation of Closet Traps.

Every closet trap, whether it be P, D, S, or V, must be thoroughly ventilated, irrespective of siphonic action. Such ventilating pipes should be of the same size as the soil pipe

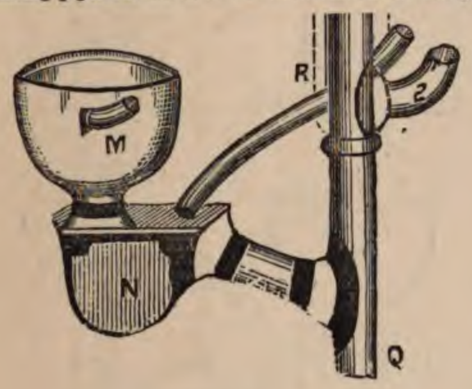


FIG. 475.

itself. They should be fixed as shown at R, Fig. 475, and H, *a*, *f*, Fig. 476, and carried by a separate pipe above the highest W.C., &c., or as shown at 25 or 27, Fig. 339. Of

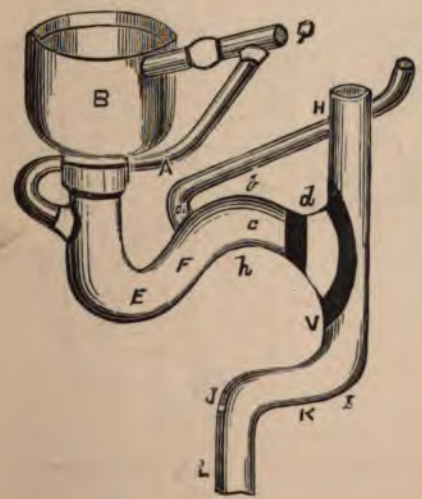


FIG. 476.

course, these vent pipes R and H may be branched one into the other to save carrying up separate pipes, but on no consideration should the pipe H, Fig. 476, be branched into the soil pipe Q, Fig. 475, below a branch inlet from another closet, or housemaid's slop closet.

Unsanitary Pipe Arrangements.

In diagram Fig. 477, may be seen a little of bad or unsanitary arrangements. The soil pipes are made to pass through the bottom of the cistern, as shown at S, and

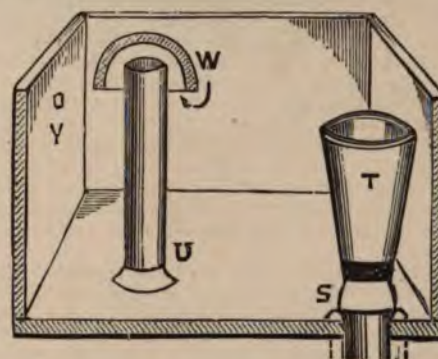


FIG. 477

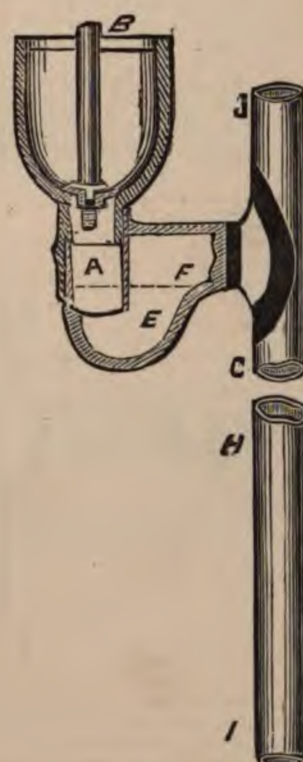


FIG. 478.

finishes with the trumpet mouth waste T, and often acts as a flue to convey the stinks from the drain into the cistern. Suppose R, Fig. 475, to be connected to the waste pipe, S, Fig. 477 [see Fig. 480], which is often to be found. When you come across such work, the best thing to do with it is to cut it off at R, Fig. 475, and turn it into some other course. Then it is a hundred to one if ever altered. Many unsanitary people for the sake of cheapness will have a disc of lead soldered over the top of waste pipe, spoiling ventilation, and use the waste pipe for cleansing out the cistern only. When these waste or overflow pipes are cut off and made to discharge over a sink, take care that the sink pipe and *grating* are large enough to carry off all the water the waste pipe will deliver. To partially repeat the above words, and to draw the plumber's particular attention, I speak of this, because it has become almost a general thing to find plumbers disconnecting waste pipes, and turning or fixing them over sinks, so that on the pulling out of a waste pipe, the sink becomes filled up, and so inundates the whole of the floors below. [*Notice*, all such waste pipes should be trapped, otherwise they act as flues to *carry the stink* from the sink direct into the cistern, a very common occurrence in cottage property, and not uncommon in larger houses; therefore trap or take the ends to another place, such as into the area, &c.]

It often happens that a trap has to be connected direct to the soil pipe, as at F J, Fig. 478; when such is the case, and D-traps are to be used, the trap should be made with the sides, top, and band lengthened, and the outlet worked round, as those shown at F, Fig. 478. Or, if half S-traps are used, they should be made longer. In fact, when I use this kind of trap, I always make them up, and with long outgoes suitable for the work, which generally saves one joint.

Cone Outlets.

I have often had to fix closet traps, both D and S, where, by reason of expense, &c., the trap ventilating pipes have been objected to, and where only one pipe, as at J, Fig. 478, and Z, Fig. 479, has been carried up to the roof.

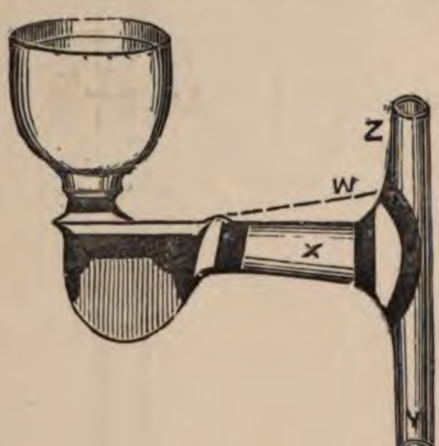


Fig. 479.

Where such is the case, make the outgo X, Fig. 479, cone shaped, and flatten its largest end to fit the stack pipe.

You can make it have as much rise as you like, as shown by the dotted lines. Such a pipe will ventilate your trap, and *often better* than by putting in a small or 2-in. separate pipe, but never fix such pipes below another closet, or the top closet sewerage will tend to run into the cone of the lowest closet pipe.

Rapid Flushing of Soil Pipes and Drains.

When making provision for rapid flushing suitable for soil pipes or drains, I use, where possible, a 6in. washer and plug soldered into the bottom of the cistern, as shown at S, Fig. 480, and I take care to have at least 2ft. of 6in. pipe to

480.

branch my ventilating pipe into, as shown in the dotted lines at 2, Fig. 480, and if possible, I carry it to the highest point of the roof. Of course, a ground-in plug and rod, or valve and chain, must be used instead of washer and waste. The reason for using the extra sized plug and 6in. pipe is to compensate for the introduction of the air, so as at this same time not to spoil the draught. And notice that the greatest care and caution are necessary in adopting the rapid flushing system, for if the pipes below Q are arranged to be shorter than the down pipe Q R S, the chances will be that you will have a fountain at the next sink or closet basin, and should the down pipe between V and L be shorter than either of the above lengths, then the fountain will show at B, and more especially here, on account of the set off, or two bends at I K J. When the top length is too long to allow of this large valve, the difficulty is easily got over by reducing the size of the valve, or you can often get over the difficulty by shutting off the water supply to W.C., and using a plunger valve as at B, Fig. 478. As a rule, the drain pipes now being fixed in all houses are 6in., and therefore very little harm will be done by the spouting up of the water in the lower part of the house. This must be left to the judgment of the plumber who orders the plug or valve for the cistern. I may say a valve nothing less than sufficient to give a good flush to the whole of the pipes should be used.

We have seen how traps and soil pipes are fixed, also we have seen the method of ventilating the same, and now it will be quite as well for me to show you the fixing of closets, and the different methods of flushing the same.

Lead Safes.

For diagrams showing the lead safes fixed, see Figs. 354, 458, and 461. When making the safes, be careful to make them to the proper size, about 3ft. by 1ft. 10in., and from 5in. to 6in. deep; they should go against the back wall and up to within an inch or so of the front riser; the ends should fit between the walls, or at least should stand past the outside of the basin, say 8in. or 10in., and well out of the way of the closet lever; and the dip pipe should be large enough, and sunk down in order to *wipe it flush with the top of the safe.* The outgo pipe D R, Fig. 481; should also be large enough, say not less than 2in. to 3in., and sunk and dished down all round, so that the overflow pipe may be opened at its

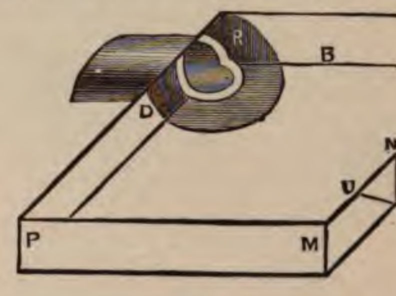


FIG. 481.

inlet end. Sometimes the top lead of the safe is covered with flashings. Five pounds lead answers very well for safes. Fig. 481 illustrates part of a safe having the angles bossed up, and Fig. 482, a safe with the three angles dog-eared, and B*E ready for turning. For method of bossing, &c., see my Roof Work, next volume.

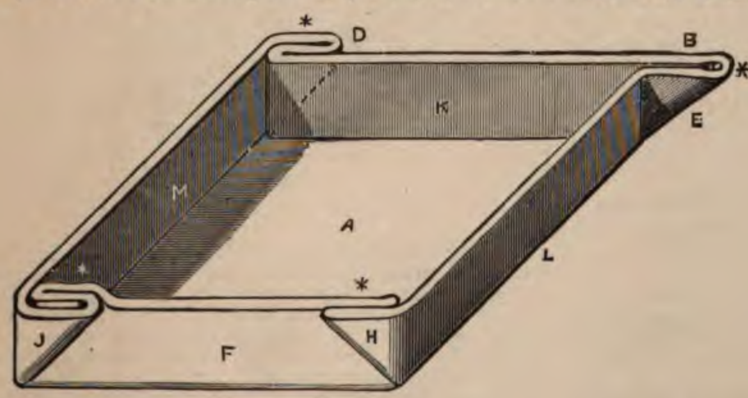


FIG. 482.

Hinged Flaps for Safe and other Waste-Pipes.

This is shown at Fig. 483. It is simply like a flap-valve which is fixed on the end of the main drain [see F E, Fig. 367] The flap may be made by the plumber from a piece of copper, and soldered on with a hinge made of copper wire, &c.

FIG. 483.

CLOSETS.

We have now seen the methods of fixing our soil pipes and traps; it will now be time to examine one or two closets. At Fig. 409 was seen the old, straight hopper basin, and at Fig. 411 was seen a decided improvement; this is Sharp's patent flush rim basin, which is now universally used. At Fig. 412 is to be seen the basin and trap with water supply, and at Fig. 413 is to be seen a basin holding a certain amount of water. There are many more such basins in the market, which may be seen at the end of this work.

I shall now introduce to your notice the valve closet, which has held its position ever since it was introduced by

Cumming, in the year 1775. This closet shown in his specification of Letters Patent has a slide valve below. After this comes Prosser, in the year 1777. He used float balls to regulate the water, and he says in his specification: "When the basin is empty, these balls act and cause the water to flow into it." Here it is certain that a valve must have been used (but this closet is something like a Latrine, see Fig. 495) so as to hold the water within the closet basin, otherwise what was the use of the float balls. Then in 1778 comes Bramah. He introduced a closet having two valves, one to regulate and control the water to the basin, the other to take it away. The closet as made by Bramah is to be seen at Y, Fig. 565. It has a ground-in 4 in. outlet valve, wooden frame, and good lead box, and is far superior to many of those made by firms professing to be the acme Sanitary Engineers of the present age.

The next is Underhay, who made the bottom valve to shut on an india-rubber seating, the idea being to reduce the cost and the chances of leakage should grit get under the valve. He also introduced a very simple air bellows regulator, see Fig. 266 at P, and after this the oil regulator, see P, Fig. 262. There are some few points which you should take particular notice of when selecting valve closets. First is the box, which should be of lead. Take notice that all the internal parts of valve closets should be made of incorrodible material. To begin with the examination of the closet properly, start at the box. This should not under any circumstances be made of iron, even though it be enamelled, for the simple reason that it should be only large enough to allow the valve to work; and if made of iron, the material naturally corrodes and filth hangs about, and if enamelled it corrodes and chips off in large scales, thus often causing the valve to get out of order, to say nothing about the filthy condition to which it very soon must become. Secondly, the overflow pipe and trap is of the greatest importance, especially since bubble sanitarians often are your masters in specifying those things they know nothing about practically; often recommending such things as iron closets and closet boxes with slopped-out overflow traps made to the very worst shape, yet they clutter about like hens with chickens. If they find a good shaped non-siphoning *self-cleansing* D-Trap fixed below a valve closet, the place that such a trap should be fixed, they would sooner die than fix such an article, and

Patent Valve Closet Box, with unsyphonable overflow trap combined.

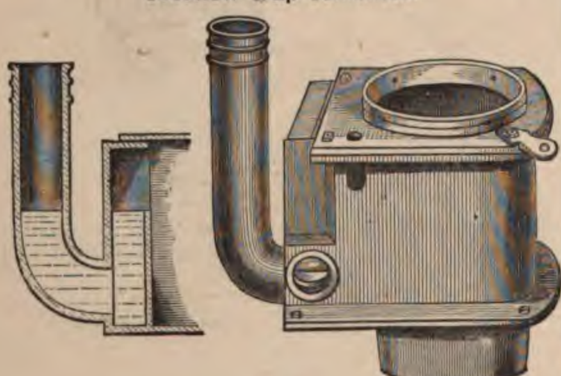


FIG. 484.

invariably recommend, and often insist, that the worst of all traps namely the half S, and often by them called a P Trap (the result of ignorance) shall be fixed, and when this is the case the momenta of water often leaves the trap unsealed, when you have to rely upon the overflow trap to the closet, and which if of a syphon shape must, owing to what has taken place, be sucked out, and the consequence is that neither trap is of any use. This is well-known, and thundreds of closet makers have tried all sorts of dodges to remedy this evil; some using valves and floating balls, others apply weeping pipes, which when the supply happens to be shut off (and this is the fatal moment) is nothing more than a snare. Some firms partially form the trap in the basin, which is far worse. The trap to a valve closet box should be *unsyphonable* and *easy* cleaning, *and sufficiently large to take away as much water as the supply pipe can deliver.* Such a valve closet box and trap, with overflow pipe, is to be seen at Fig. 484. It will be seen from the diagram that the trap is formed in the end of the lead box, and the partition or diaphragm is flat, and holds more water than the inlet pipe, consequently it allows of all the water being sucked from this part of the pipe, and which admits at the same time of a great scouring action; but when the syphonage is over, the water in this trap part of the box falls back, and effectually seals the inlet pipe. Of course this trap is fitted to iron boxes; but use lead.

FIG. 485.

Fig. 485 illustrates a common valve closet with iron box and S-Trap for the overflow pipe; it also shows a weeping pipe from the supply arm to the overflow trap to supply water after the trap has been syphoned out, but this at times, as a matter of fact, is another fallacy, for what is the use of this pipe when the water supply is shut off? and this is the very moment that the danger arises, there being no water forthcoming to counteract the bad effect always produced with such traps when fixed below or to valve closets.

Some makers fix the overflow pipe on the wrong side of the closet box, as shown at 32, 34, 35, Fig. 628; the effect of this is that when the large valve opens it shoots a little water into the overflow trap, at the same time solid matter is injected and quickly chokes the trap.

Having explained the necessity for selecting a valve closet whose overflow traps will resist all possibility of syphonage through every source, as well as being thorougly self-cleansing, there still remain items for consideration. Amongst the foremost of these is to try the stability and soundness of the lock; for this put your fingers upon the top part of the valve, and try, with some force, to push it down, and if you can do so it is not sound. Pan closets are also tested in this manner.

Having proved the lock of the closet, next examine the outlet valve by pulling up the handle to see if it opens full way; drop the handle, and notice whether it hangs up or don't shut properly down, if either discard it. Now look for the stability of the brass work, and examine the dish. This may appear a good thick bit of brass work,

FIG. 486.

yet it may be as thin as paper; put your fingers under the edge, your eye may have been deceived, but your fingers will soon detect whether it is a sham thick dish or not. Always select the basin having a straight arm coming in direct from the back and into a flush rim. With this arm there is no stop required to split the stream, but in flush rims having the arms coming in sideways, there is the objectionable stop. Notice the holes in the overflow and the size of the overflow itself; the holes should twice equal the bore of the trap or overflow pipe. Now examine the box, see Fig. 628 at 26; it should be lead, see page 200. Examine the collar, Fig. 628 at 19. This should be of brass, but you may find it iron, and made to save expense; though this closet may have quite as good workmanship in it as one with a brass collar, certainly it is not so good.

Repairing Valve Closets.

To repair the bottom valve of a valve closet, first untie the putty joint at 36, Fig 484, and unscrew the seating plate at 20, 23, &c.; take the seating and valve off the box and put in a new rubber ring *the same thickness;* this ring may be had from any closet maker, or perhaps it will suit you better to let him put the ring on. When refixing the valve see that you make the red lead joint perfectly sound, well puttying round the axle. Most London plumbers take the closet and valve box up, and send the lot away for repairs, but this will not always suit the country workman.

JENNINGS' CLOSETS.

Self-Closing Valve Closets.

Fig. 487 illustrates a valve closet, which after the handle has been held up for a given time, closes of its own accord. This is done by reason of there being a piston and cylinder attached to the lever as shown at JENNINGS. P is the cylinder wherein the slack fitting piston works in a suitable fluid, and in a similar manner to the waste preventing valves shown at D B, Fig. 637, but with cylinder attached to the lever of the closet; or instead of a slack fitting piston, a sucker plate or disc similar to those shown at Fig. 620 and Fig. 619 may be employed; or this may be accomplished in many ways. I believe Wm. Ross, of Glasgow, who has brought out many useful inventions relating to water supply, was the first to apply a self-closing valve to the lever of the

FIG. 487.

valve closet. At any rate I saw him some while ago, and he told me he was the first to do so.

Jennings' Closet and Trap in One Piece.

These closets are very largely used all over the world, and are excellent closets. Fig. 488 is a sectional view showing

FIG. 488.

the outlet valve X, also the trap above the floor; it also shows the ball trap on the overflow just above the outlet valve X. The water supply to the closet may be worked by what is known as Jennings' Hydrostatic valve working with a float, or by his regulating valve Fig. 534 or 537, or with cranks and wires, etc.

Smeaton's Closet

This closet, Fig. 489, is a very good one, and, as can be seen, may be supplied with water similar to Jennings'. Here the closet basin is cemented to a cast iron body, in which is the valve seating, the dish plate, and pull. It can be seen that here is also the overflow attached to the pull as in Jennings', but the trap here formed is like in principle to Jennings' improved self cleansing bell trap [see Fig. 299]. Smeaton has many methods of supplying this closet with water to suit circumstances; sometimes on the ball valve principle, whilst at other times it is worked with cranks and wires. I should prefer these Jennings' and Smeaton's closets if the handle part were not so roomy, as I find that this part becomes fouled.

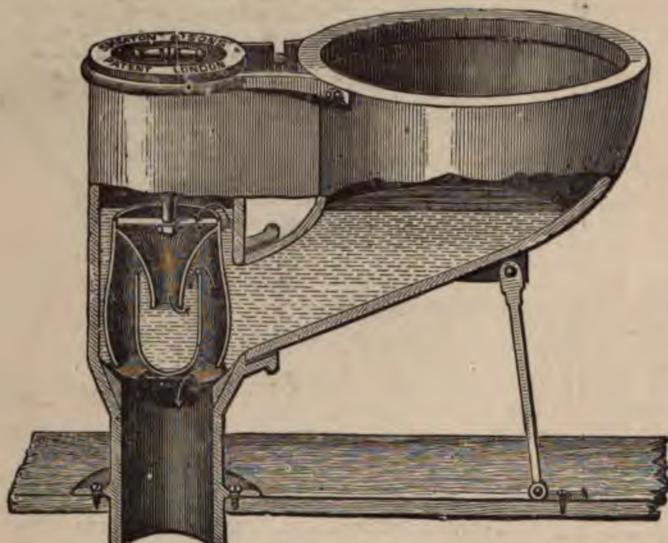


Fig. 489.

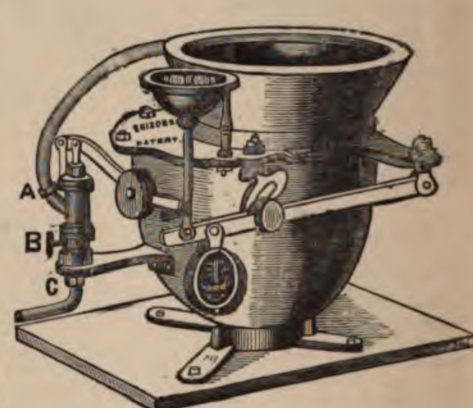


Fig. 490.

Fig. 491

Pan Closets.

This class of closet is very much in use about London, and, in fact, all over England. Fig. 490 illustrates the regulator pan closet. On the left hand side of Fig. 491 is an illustration of this closet with a flat plate for handle.

On the right hand side is to be seen this closet with sunk dish and pull, it also illustrates the top plate having a safe round it for bedding the basin into.

[For section of the Pan Closet, see Fig. 264 and Fig. 461. The Pan Closet basin is also shown at BASIN.]

These closets are dirty internally, and unless you have some special means of cleaning them such as Mr. Banner has invented, they, in my opinion, are to be condemned, but as I know many of the craft will fix these closets, and moreover, many architects do specify them, it is my duty to speak of them without prejudice. Fig. 490 is the regulator closet. The basin is simply bedded on the top of the container, and when doing so care must be taken that it is bedded waterproof, and the bottom part of the basin must be fixed central with the copper pan, and in such a manner that it will not touch. Sometimes you will find a spreader sent out with the basin, and which you will have to fix. When this is the case simply hold the spreader central over the supply hole, and up against the rim, then with a round pointed bradawl scribe the back part of the spreader through the screw holes in the basin, after which with the tang of a file, &c., bore the holes to the size of your fixing nuts and bolts; then cut a piece of leather $\frac{1}{8}$in. thickness and from $\frac{1}{2}$in. to $\frac{5}{8}$in wide and the length of the fan or spreader; then place the leather at the back of the spreader, or between the spreader and basin, and put your screws, the heads inside the basin, and screw it

up with properly fitting leather washers at the back of the nuts. Should the spreader fit the basin too tight, then with a limp putty knife, Fig. 32, open the spreader to give the desired water supply.

Some plumbers use red lead putty instead of leather at the back of the spreaders, and, if properly manipulated, it will answer every purpose.

Repairing Pan Closets.

When taking up these closets for repairing, some plumbers take the whole of the container from off the safe of the closet, and the chances are that the closet is never again fixed in its exact position. The proper way is to unscrew the top plate W of the container A, Fig. 264, then thoroughly clean the container out and paint it, leaving it in its position.

Putting New Copper Pans on.

When this has to be done, care must be taken not to injure or bend the axle, and it is done as follows. Unscrew the tumbler pin which works through the cammed crank, then unscrew the lever, and handle, dish, and pillar, and first axle bearing, and loosen the second or back one so that the axle and copper pan may be taken out without bending; now file or otherwise loosen the ends of the rivets and take off the pan; get another of the same size, and be careful to put the new pan in the position of the old one, and clean the ends of the rivets for soldering; now rivet it on to the axle, and neatly solder over the heads of the rivets, when the closet can be put together as before.

Testing the Mechanical Action.

To test a pan closet, pull up the handle and try its smoothness of action. If it works rough it is not well made. Now, put the knuckles of the fingers into the pan and press downwards; if the pan opens, the locking arrangement is imperfect. The pan should rather break or bend than open.

Fig. 492.

Conversion of Pan Closets from an Unsanitary to a Safe Condition.

For this refer to Fig. 490. Take the basin off and top plate, thoroughly clean out the closet, take off the copper pan and axle, then get a piece of 4in. leaden pipe, as indicated by the two lines at S S, and fit this pipe to receive the bottom part of the basin, and to enter into the trunk of the closet; put all into its position excepting the copper pan and axle, and fix the lead pipe. Now, with 3 of sand and 1 of cement, fill the container solid up, and fix your basin, when you will have greatly improved the pan closet at a very small cost.

Closets Without Woodwork (*Seat excepted*).

These closets are shown at Figs. 492, 493, and 494, and are constructed with a view of keeping the underneath part clean.

Hospital Closets.

Fig. 492 illustrates a closet made by Jennings, for hospitals, &c. In the bottom of this closet, as also in Figs. 413, 576, 549, &c., may be seen a shallow bed of water, which prevents the bottom of the basin becoming foul; but in the Fig. 492 there is to be seen an improvement, which consists in providing the water-bed with a distinct supply of water, which urges forward the soil from the water-bed. There is also the usual arrangement of Sharp's pattern flush rim round the top of this basin, which thoroughly cleanses the sides. There can be no question about the efficiency of this closet if the supply of water is sufficient, and in reality nothing better can be desired.

Fig. 493 illustrates a closet formed with the hopper and trap; the lid is here shown up and out of use. This closet is very good for public-house watering-places. Fig. 494 illustrates the closet with the seat down, and as soon as it is brought down as shown, the water supply is automatically turned on. The closet basin has little spikes on its top flange, so that the user is almost compelled to pull down the seat before he can conveniently use it, which gives the supply of water.

Latrines.

This system of water closets, as illustrated at Fig. 495, is but little known, and, as may be seen, consists of

Fig. 494.

any number of highly glazed vitrified stoneware or enamelled iron pans, having a large water surface, and connected by cast iron or good stoneware pipes; at the lower end of the range is fixed a discharge and overflow valve, generally placed in the sergeant's, master's, or foreman's closet, which is kept locked, so that there is nothing with which evil-disposed persons can interfere or tamper. This is of importance in buildings such as workhouses, lunatic asylums, factories, &c. The discharge plug of

Fig. 493.

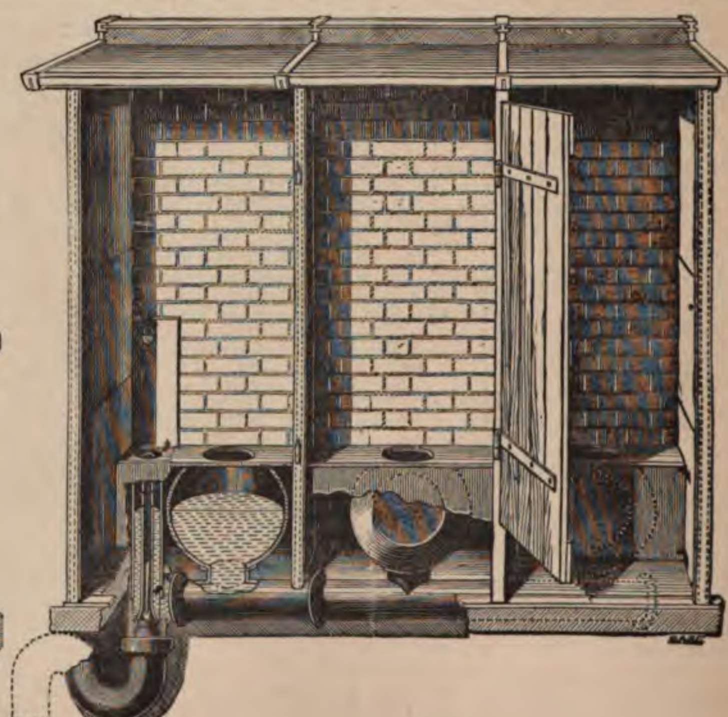


Fig. 495.

Latrines should be raised as soon as the Latrines become dirty, or as often as the water supply will allow, the supply of which can be regulated by a valve or stop-cock.

In cleanliness and freedom from smell, these Latrines are far superior to the ordinary system of open and continuous troughs, which it is almost impossible to properly cleanse, and which (circulating over a large surface of impurity and filth) is actually manufacturing the stench it is desired to avoid. The above Latrine is made and supplied by G. Jennings. I have made Latrines similar to the above from 4in. drain pipes with junction pipes to receive hopper basins, and the plug formed with the usual 4in. washer and waste; but now the whole can be bought ready made.

Builders' Workmen's Closets.

These closets are simply Latrines, sometimes having the tops let down level with the ground; at other times these closets are provided with a scaffold pole for a seat. When there is no pole seat the men have to simply squat, which, to say the least, is not to an Englishman, a convenient method of rest.

I really do not wonder that builders adopt this squatting arrangement when it is known that their workmen will often stay in these places for hours together, smoking and wantonly talking the time away. I personally have many a time seen a dozen men in these places holding arguments for hours together, to the loss of their employers.

Setting Closets and the Materials.

When setting closets of the best class, do not use common putty, as it very often in the summer time gives off an offensive odour, which some people are apt to take for a drain smell. The best way to make the putty is from red lead and gold size, as this sets hard and does not give off an oily smell, which nearly all other kinds of putty do

URINALS.

There is a vast variety of urinals in the market, one maker claiming this, one claiming that, and the other claiming something else; but perhaps the greatest peculiarity is that nearly every one can make each other's pattern, and this being so we may take it as an all round affair. Nearly every one has seen the public urinals at railway stations, restaurants, &c., and perhaps some of generally supplied with a simple pierced leaden, copper, or brass pipe bent, or otherwise fitted at the back and wings of each stall, and governed by a stop-cock, spindle valve, or their equivalent. Some years ago, when foreman of plumbers for the late John Jay, contractor for the Metropolitan Railway, Great Northern, and Euston termini, I fitted some hundreds of such urinals, which to this day

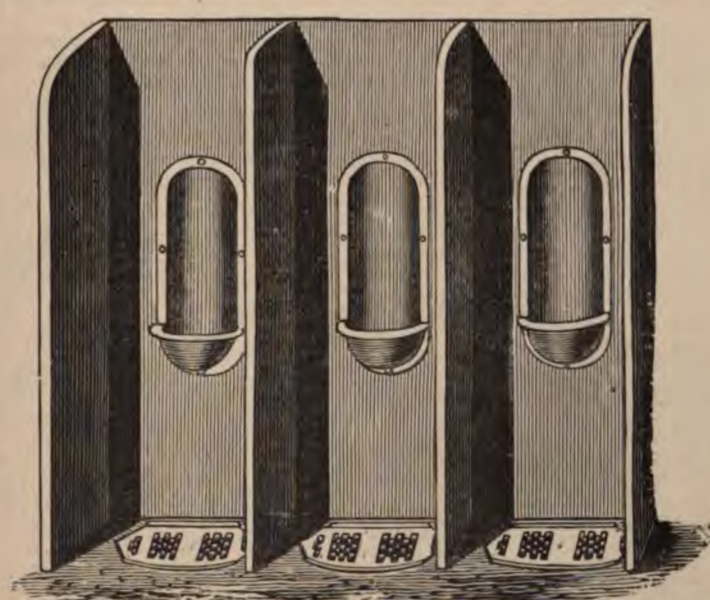


FIG. 496.

those in connection with the railways are of the commonest kind, and formed with slate, after the fashion of that shown at Fig. 496, without the treadles or the earthenware cradles shown fixed half way up, which are here illustrated, and will be explained afterwards. Such urinals as these are are in excellent working condition; and besides these, when foreman at Jackson and Shaw's, contractors, Earl-street, Westminster, some sixteen or eighteen years ago I fitted a large quantity at Brixton, Peckham Rye, Queen's Road, Hatcham, and Rotherhithe Railway Stations, which

I some days ago visited, and all of which are in thorough working order, showing at once that these simple urinals for such purposes, are not to be lost sight of.

The Cradle Urinal.

This is shown at Fig. 497, and which may be had with lip as at T V, Fig. 498, and may be supplied with water through a simple stop-cock, or by a Tylor's or Lambert's

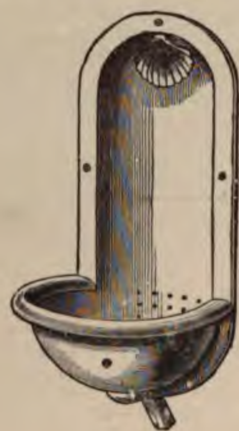


FIG. 497.

waste-preventing valve-cock, as shown at A B F E, Fig. 499, and also at I M N, Fig. 498.

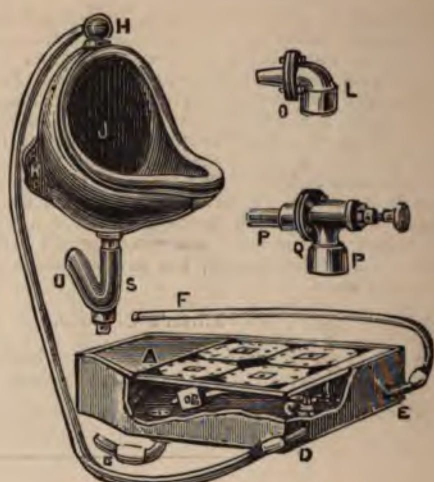


FIG. 500.

is fulcrumed on the pin B. This weighted lever also is made to govern the water supply valve at B. Fig. 500 shows the arrangement of pipes. It will be readily understood that by treading upon the treadle of the urinal, that the pedal, if not too heavily balanced by the balance-weight, A, Fig. 501, will descend, thereby bringing up the lever and weight, A, together with the spindle of the water supply valve, when the water will run into the urinal during the time the urinal is in use. Here is all that is absolutely necessary for a urinal.

These cradle urinals, with treadles complete, are shown fixed at Fig. 496, and Fig. 502 illustrates the urinal Fig. 496, as fitted in section.

FIG. 499.

FIG. 498.

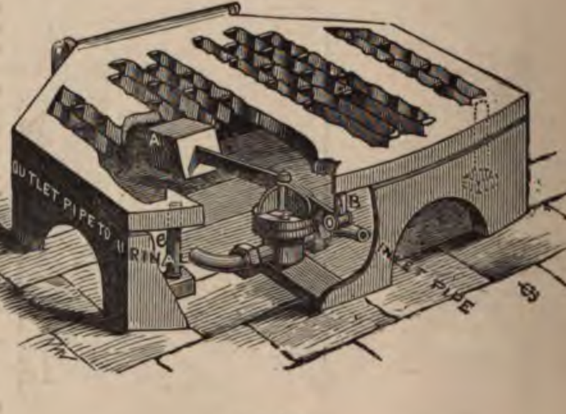


FIG. 501.

These cradle urinals may also be supplied with water through a valve governed by a treadle, as shown at Fig. 500.

An enlarged view of the treadle is shown at Fig. 501, which may be briefly described as follows:—The top or perforated plate is, as may be seen, hinged at the back, and underneath this top is fixed a weighted lever, which

Fig. 503 is a front view of a cradle urinal, which is fixed similar to that shown at Fig. 496, with this difference, that the valve is fixed in the box, D K, with a regulator K. This valve E is worked with a rod J; the lever of the valve is kept from too suddenly closing by the use of the regulator K. It will be manifest to all practical men that any of the actuating arrangements of

the water-valves belonging to either closets or urinals that have hitherto been or will be described and illustrated, may

FIG. 502.

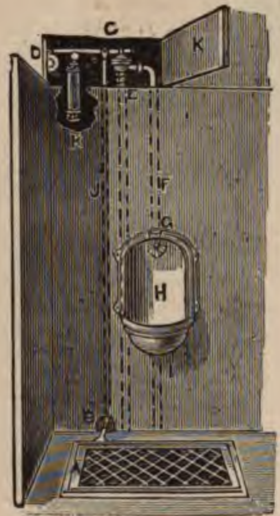


FIG. 503.

be worked in with each other accordingly as circumstances may require; for instance: the door in Fig. 559, &c., may be made to work the valve B, Fig. 501, or the lever D in Fig. 503, &c.

It is of the greatest importance that the valves and pipes should be thoroughly washed and cleaned after fixing, to prevent the possibility of any dirt or other extraneous matter being deposited between the face and seating of the valve, so as to avoid any chance of leakage.

When fixing urinals great care should be taken to have proper flushing arrangements, and, in fact, for some places the plumber must employ self-acting flushing cisterns, to be hereafter described. [See Fig. 511.]

On the left hand side of Fig. 504 is an angular urinal, with lipped basin, which may be worked by any of the before-mentioned contrivances. On the right hand side of Fig. 504 is an angular urinal showing treadle arrangement as at Fig. 501, and at Fig. 505 are two urinals such as are shown at Fig. 504, but not lipped.

Urinals.—"Running Water Supply."

Perhaps one of the simplest kinds of water-supply to serve, especially to public urinals, is the ordinary running supply bent pipe as at G H, Fig. 506, which, of course, may derive its supply from any source. The pan B holds a large body of water, and has a standing waste that receives the overflow, and which can be lifted for emptying, say once in 24 hours. The pan is sometimes made to empty itself automatically by means of a siphon or other equivalent arrangement. This kind of urinal is greatly in use in the public buildings and places about London.

The fixing of urinals is generally done by screws, and by the urinal lugs T T, Fig. 498, screwed to a plugged wall.

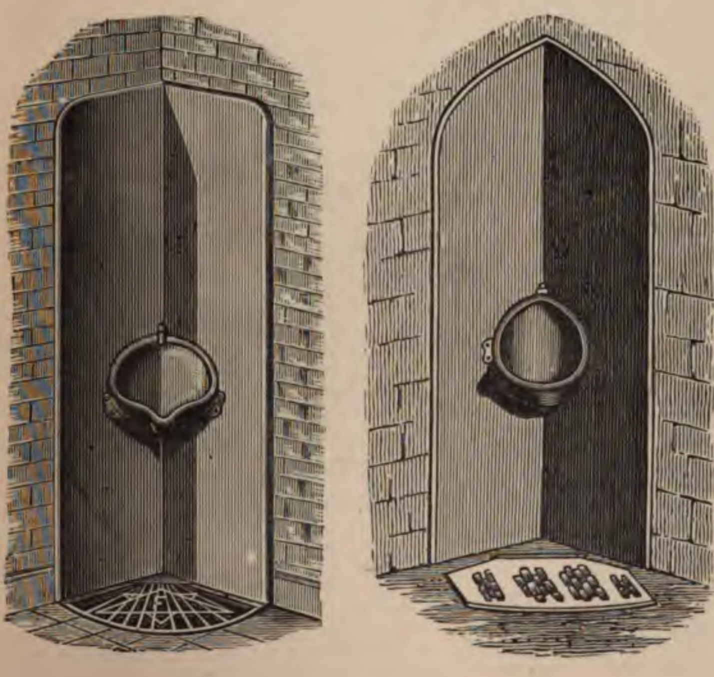


FIG. 504.

FIG. 505.

Heights for Urinals.

The proper height from the top of the lip V to the floor should be 2ft., and should not ever exceed 2ft. 4in.

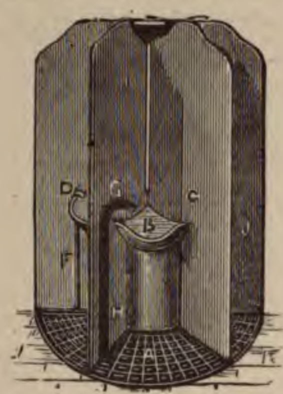


FIG. 506.

Outlet of Urinals.

All urinals should be properly trapped with self-cleansing but siphonless traps, and in such a manner that the trap can readily be got at to be cleaned out, which can readily be done with spirits of salts, etc.

All pipes leading from urinal traps should be of only sufficient bore to keep themselves clean by the scouring action of the water—that is to say, the pipe should only be of sufficient size to allow of the outlet of the urinal and the water supply thereto to properly or fully fill up the pipe, and all waste pipes from urinals should act as siphons, in order that the scouring action may be fully maintained.

Fixing Supply Pipes to Urinals.

This is best done as shown at I, Fig. 502. Here is the supply-pipe, which is made good to the arm of the urinal by means of a putty joint; or a really good plan is to have a socket, O, shown in the section, with centre pipe as at P, to enter the inlet, and socket O to be filled up with red and white-lead and simply pushed over the arm as at N, Fig. 498, when the surplus red-lead will be pressed out and joint made. O L, Fig. 500, is an elevation of the socket, but bent as at O, to show that the pipe may be brought in from behind, and the socket unscrewed at the flange to allow the urinal to be taken down at any time without disturbing the walls, &c.

Lavatory and Urinal.

Fig. 507 is a lavatory basin and urinal combined. The urinal is made to swing with the door, and in such a manner that by the action of opening the door the water supply is opened, when the water runs full-bore to flush out the urinal.

These urinals are made to suit almost every kind of furniture, and are made left and right handed, the right handed being shown at Fig. 508, the water supply at 508 being the waste from the lavatory basin, which may be connected with rubber pipes, &c.

Fig. 509 illustrates a shut-up wall urinal for fixing in offices, and in places that will not allow of such apparatus being seen; it can be used as a sink, &c.

Fig. 510 shows the urinal closed up. These urinals are made to flush themselves out automatically every time that they are opened for use, but owing to the great amount of space for allowing these urinals to close, they are inclined to become dirty, and require constant attention.

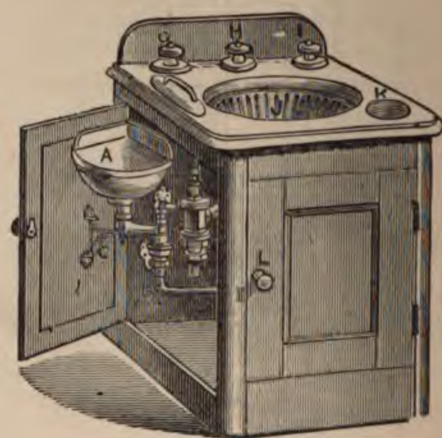


FIG. 507.

Fig. 511 illustrates a three-stalled automatic flushing urinal which can be made to flush as often as required, and I may say that the provision for a proper system of

FIG. 508.

automatic flushing, and an arrangement of pipes facilitating periodic cleansing and sweeping out all wastes, thus removing, and preventing the possibility of smell from the accumulation of sediment and salts of ammonia, which are freely deposited by urine in solution with water, is a great desideratum, which should always be held in view when fixing urinals, whether on a large or small scale.

Fig. 509

Fig 510.

Fig. 511.

CLOSET WATER SUPPLY.

Closet-Pipe Stop-Cocks.

When selecting stop-cocks to be used on pipes in connection with closets, great care should be taken to select only those having a straight full-way, known as a "round-way ground in stop-cock," shown at Figs. 512, 513, 514, 515, 516 and 517.

Stop Valves.

On reference to Fig. 518, it will be easily observed that the seating B is so constructed that the water is greatly retarded in its progress, for these reasons:—It first strikes against the partition W, and rebounds from there to the bottom Z, from Z to S, thence from S through the seating

Fig. 512.

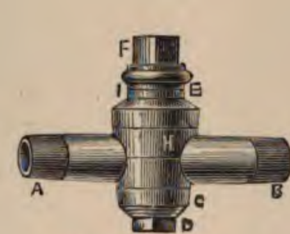


Fig. 513.

Fig. 514.

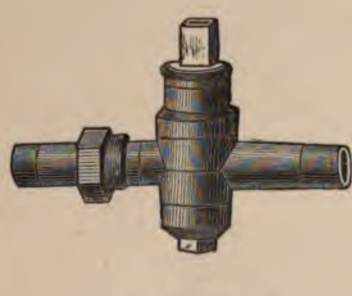


Fig. 515.

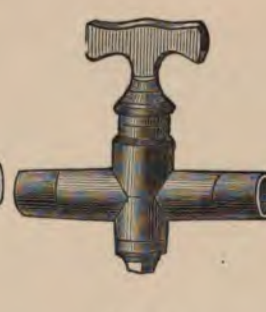


Fig. 516.

Fig. 517.

Bow Key Cocks.

Fig. 512 illustrates a bow-key stop-cock. The reason for fixing bow-key stop-cocks is in order that they may be readily turned with a piece of iron, &c.

Square-Headed Stop-Cocks.

This stop-cock is illustrated at Fig. 513. The reason for fixing such cocks is that they can be turned only with a spanner. This prevents them being turned only by those having the right to do so. Fig. 515 is this stop-cock with union for disconnecting the pipes when required.

Crutch Key Stop-Cocks.

This is illustrated at Fig. 516. The object for making this stop-cock thus is in order that the cock may be turned freely with the hand, but such cocks do not work easy past ¾in in size. Fig. 517 illustrates the ground-in cock in section.

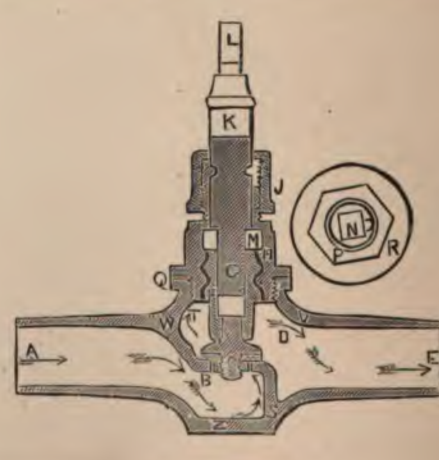


Fig. 518.

B, and up against T, back to D, from D to X, and finally onward along E. Now this diagram and explanation shows distinctly that the water has to take no fewer than six different sharp curves before it can pass out of the stop-valve or cock; and, curious as it may seem, the shell and seating of this stop-valve is the one generally adopted by our water companies.

Farther on I shall give the full particulars of a practical test of the loss of head-water by the use of such stop-valves in town and other water supply, Vol. 2.

Fig. 519 is an elevation of the last-named stop-valve,

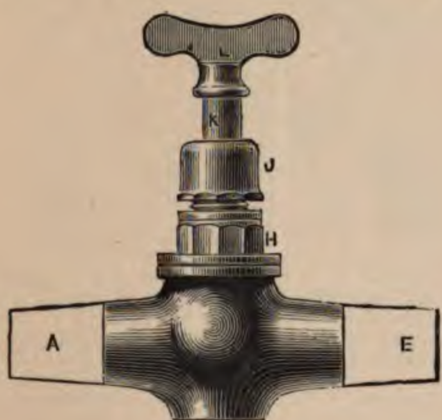


FIG. 519.

showing the stuffing cap, the squares on the cap, and the tinned ends; A the inlet, E the outlet. Fig. 520 illustrates the well-known Chrimes's celebrated patent (No. 10,837, A.D. 1845), Rotherham shell-pattern cock. In the top of

FIG. 520

this cock there is a small set screw (on the right hand side), which prevents the top from unscrewing when the spindle is being turned, and in this cock may be seen the ordinary stuffing box and nut. Sometimes this stuffing nut is set with a set screw, to prevent its turning with the spindle.

Double Shut-down Stop Cocks.

This class of cock is illustrated at Fig. 521; it is simply a stop cock having a second seating with ground-in plug. The object for fixing this cock is plain to practical plumbers. The ordinary screw-down cock valve is made of leather or rubber, which after a few years becomes perished with the water, etc.; or, if not perished it is ten to one that a small piece of stone or something else will be found under the valve when it is wanted to be shut down for repairs, etc. This entirely prevents the pipe being soldered, but if you first close the stop-valve with the ground in plug, and then take the top off and clean out the seating, or if required, drop in a new rubber valve or piece of leather on the old

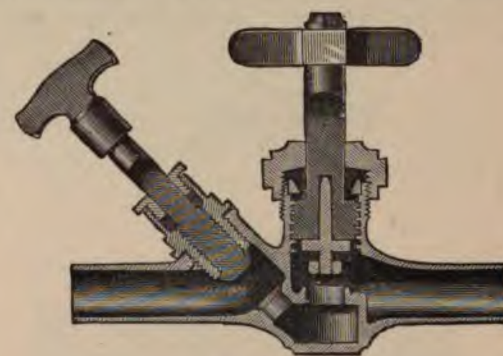


FIG. 521.

one, you can make sure that the main will be shut down, when you can go straightforward to work. This cock is made by Messrs. J. Fell & Co., also by Hayward Tyler, but with the valve working from below, it is known as Beach's patent.

Diaphragm Stop Cocks.

This cock is illustrated at Fig. 522, and is known as Lambert and Carter's patent, 6,851, of A.D. 1835. They are very

FIG. 522.

largely used all over the world, but owing to the diaphragm being made of rubber, it does not last so long as the cock made with the stuffing box. Of course Lamberts make such stop cocks as shown at Fig. 520.

Straight Full-way Stop Valves.

Should you require a stop valve to fix on a length of pipe where the stream should not be retarded, for instance, to fountain jets and the like, or in places where you want all the water that a pipe can give, then revert to a properly constructed cock or valve. Fig. 523 illustrates one of Warner's, which are the best to be had for such purposes; in fact it is the proper shape to make a stop-valve for all kinds of work, and will be readily understood by reference to the diagram. K is the ordinary spindle having an endless screw at the bottom, which works the quadrant E, and which, in its turn, works a valve D, which is brought to bear upon the seating at C, when the water will be shut off. It will be seen by reference to the drawing, that by this simple method a clear water-way is obtained, the

disc being drawn by the screw or worm entirely out of the way; thus all the advantages of the ordinary sluice valve are obtained at much less cost, and the liability to set fast and get out of order entirely obviated. They are adapted for all purposes, for hot or cold water, and equally suited for high or low pressure; and in case of need of repair, a new valve seat can be applied without removing the body or case of the valve.

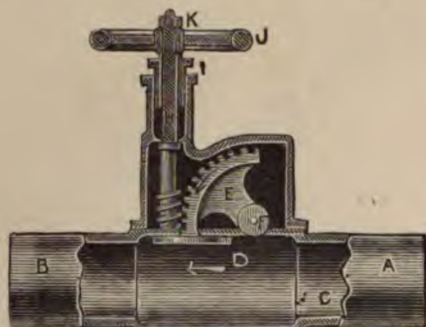


FIG. 523.

Self-closing Stop-cocks.

Fig. 524 illustrates Lambert & White's patent, 1,836, A.D. 1872, self-closing stop valve, for fixing to urinals,

Fig. 524.

water closets, etc. These valves will be spoken of hereafter; they may be regulated to give from half a gallon to whatever quantity may be desired. [Also see F, Fig. 525; the principle of this latter cock's working is shown at A F, &c., Fig. 499; also see Waste Preventers and Waste Preventing Valves and Cocks, Figs. 561, 562 and 563.]

Closet Stop Valves and Cocks.

Now we are upon the subject of stop-cocks and valves, I will proceed to explain some of the closet valves which are in the market, though not one out of twenty plumbers will ever get a chance to thoroughly investigate the whole of these valves, otherwise than through the medium of my writings. I therefore give them a place here in order that he will be able to repair and fix any of them, should he be called upon to do so. It is a fact that the plumber never knows before he is called into a strange house, what kind of valve he has to cope with. I may add that there is quite as much skill required to manage and repair some of these intricate valves as there is in any other branch of the plumbing trade; therefore do not run over them as though they were too insignificant to engage your thoughtful attention. Besides, thoroughly understanding them for repairs, etc., you will find that by having a thorough knowledge of the many different valves, you can often select those most suitable for the different work which you may have to execute; and as sanitary plumbing very much depends upon the plumber's knowledge of the valves most suitable for his work, it is another reason why I should thoroughly explain and illustrate them in this work. I will begin by introducing to your notice the stool cock with flanged top and stuffing box.

Stop-cock supplies to Hopper Basins.

The Stop-cock at F, Fig. 525, is one of Tylor's Waste-not patterns, but for the present purpose let us assume it to be an ordinary flanged stop-cock. Years ago it was the

FIG. 525.

usual method to fix a simple stop-cock J F, as shown at Fig. 525, and 526, for the supply to servants' closets, and, in fact, some thousands are so fixed to this day, more especially by provincial plumbers. Under these circumstances I think it will be not out of place to suggest the best method to adopt in fixing the same. Fig. 525 illustrates a basin with the description of supply we now have in consideration. J is a fall-down kind of hinged handle, an enlarged view of which is shown at right hand side of the diagram; F the cock, B 18in. (or about) of lead pipe from the cock to the arm of the basin, A the putty joint, E the supply pipe. It may readily be seen that any kind of cock may be used; but those generally selected are ground-in. Now, as some of the water companies have raised an objection to the use of the stop cock for supplying closets, on account of its not being absolutely and thoroughly self-closing, the contingency has been partially met by bringing into use the "Stool-cock," and effectively by the adoption of the valves, Figs. 524, 561, &c.

Stool Cock.

This is fitted with a pull-up lever and pull, as shown at D B A, Fig. 526, or the same end may be accomplished by

FIG. 526.

the use of a self-closing stop or bib-valve, working on either the diaphragm or the falling piston principle. For which see Figs. 561, 524, &c., &c.

CLOSET VALVES.

Valves should have a clear water way or passage through the seating, and the valve should lift at least half the height of the diameter of the water passage through the seating (for the proper lift of valves for the discharge of liquids, it is only one-third the diameter; this, however. has nothing to do do with the case in point). The instant the lever of the closet-valve begins to descend the valve begins to close, so that the higher the valve is lifted the longer will the water be allowed to run full bore.

Stool Valves sometimes called Cottage Valves.

The best kind of valve for fixing under the seat of a w.c. is shown at Fig. 527. It is known in the trade as the stool-valve with stuffing-box, excepting that this diagram shows an improvement at M, consisting of the rocking standard instead of its being fixed [see Fig. 543]. Now, were it a fixed standard, the pin at P, Fig. 527, could not be used, but the lever would then slide through an eye fixed upon the spindle D, as in I, Fig. 543. The parts are as follows:—R, Fig. 527, is the lever which actuates and governs the valve, A is the inlet, C the indiarubber valve, resting upon the seating, D the spindle working through the stuffing-box F, but may otherwise be made to work an indiarubber or some other flexible diaphragm, in lieu of

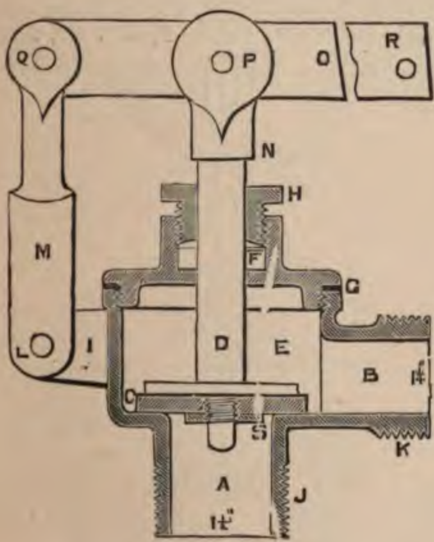


FIG. 527.

the stuffing-box (which will be described and illustrated further on at Fig. 543); B is the outlet, which must be connected by a short piece of pipe [see H K, Fig. 550 and A B, Fig. 525], about 18in. long, to the arm of the closet-basin. This connection is usually made with a putty joint; but in some instances, and not unfrequently, is effected by a properly-made soldered joint. These fittings are generally attached to the spreader (this spreader is by some persons wrongly yclept a fan; the proper title, however, is "spreader," inasmuch as it serves to spread out the water into a thin layer over the surface over the basin).

For the method of fixing this valve, see Fig. 550. Fig. 529 illustrates the valve with lugs E, for screwing the

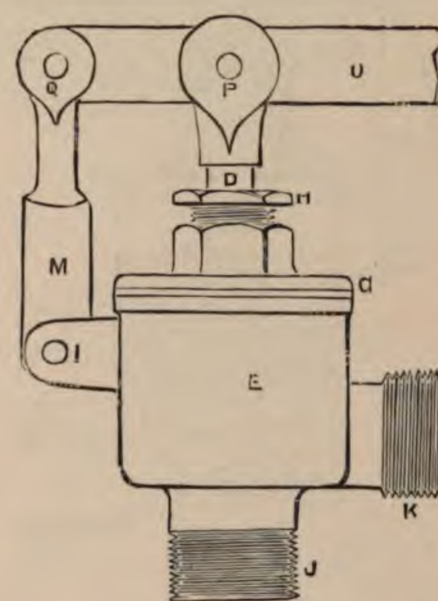


FIG. 528.

valve to wood or brick, &c., as shown at E, Fig. 545, &c., or as the case may be, also the dish B, and pull as fixed.

For repairing the above valve, first take off the lever by taking out the pins, P. Q, Fig. 528, then unscrew the top G, which is sometimes put together with three or four cheese-headed screws, as shown at H, Fig. 529; then take out the valve and re-rubber the same. Should the stuffing-box, H, leak, then take out the old packing, and be careful not to spoil the leather washers (if so fit new ones); then

FIG. 529.

with some well-tallowed hemp wrap it neatly round the spindle and press it down into the stuffing-box. Put on the top leather washer, and screw down the packing-nut, but not too tight, only just sufficient to make it water-tight, and all will be right. When screwing the flange down with small screws, do so evenly, viz., put the screws in all loose, and screw each screw equally.

Sometimes these valves are fitted with retarding mechanism, such as a cup-leather, &c., for which see U T, Fig. 530, which represents the same kind of valve, only

that it has some additional working parts, which, in my opinion, should be fitted (or their equivalent) to every closet; these parts are for the purpose of retarding the descent of the lever R. This retarding mechanism is

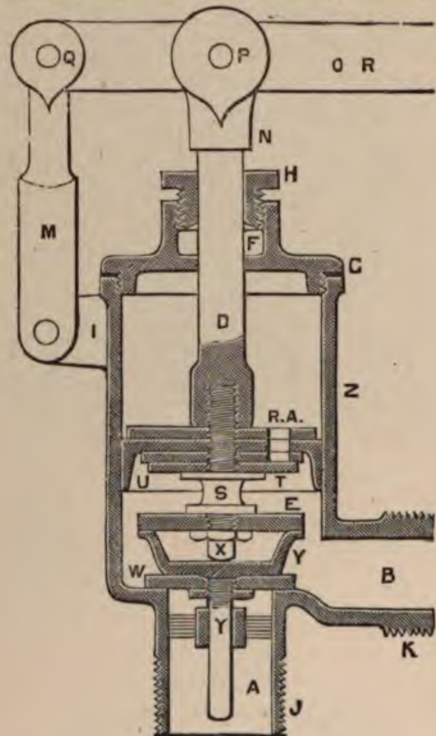


FIG. 530.

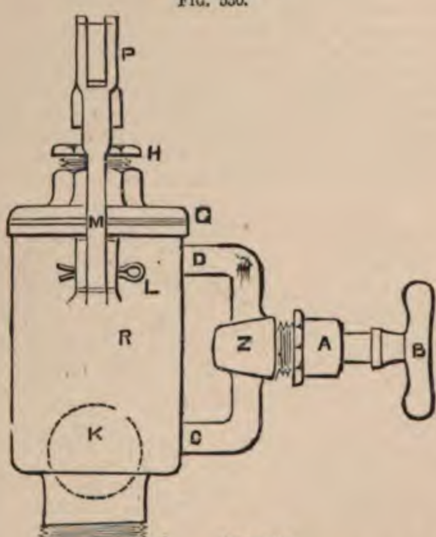


FIG. 531.

simply a solid piston bucket, or sometimes an india-rubber or other flexible diaphragm is substituted; in this diagram is shown a cupped bucket U. The action of this valve is, that the raising of the lever R brings up the piston-rod or spindle D, and with it the inverted cup-leather or bucket U; but, on suddenly dropping the lever, the valve T will close and prevent the too quick return of the water from below to above the bucket, so that this would keep the valve V W always suspended from off its seating. This would render the valve useless if not allowed to descend; but to counteract this contingency it is usual to employ a regulator-cock, or something equal thereto—*vide* Z, C, D (end elevation) Fig. 531; this tap, or other regulator, regulates to the greatest nicety the fall of the lever, also the valve W, Fig. 530, within a given time, and in proportion to the opening of the water-passage through the tap and from below to above the piston. In this dia-

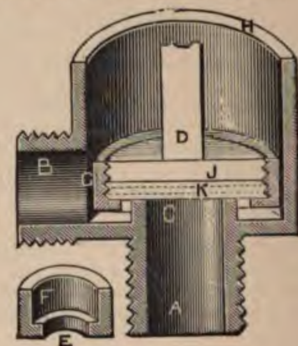


FIG. 532.

gram the valve is converted into a waste preventer by the simple use of the "boy's" sucker E, Fig. 530, which on

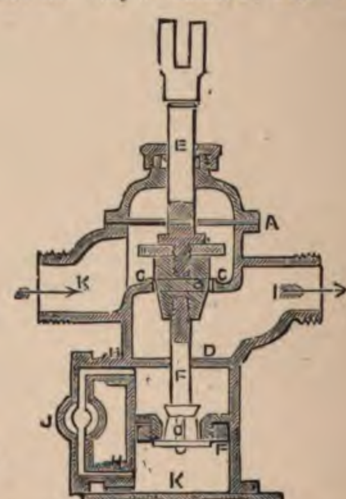


FIG. 533.

raising the spindle D, and the sucker E, takes up the valve-dish and with it the valve; this valve after a few seconds drops off again, and so closes the valve-seating. Notice: In this case B is the inlet and A the outlet, in order that the valve may be closed by the pressure of the water behind it. The rubber of the valve in this case must have its edge bound down as at G K, Fig. 532, to prevent the edge of the rubber being drawn through the valve seating. Caution—The sucker arrangement in Fig. 530 is the subject of a valid patent, and all the other diagrams having this appliance.

Fig. 533 also illustrates the retarding mechanism F G E fixed below the valve; this kind of retarder has been very

extensively used in closet work by Underhay. It is also to be seen in Cornish steam pumping engines, and is known by the title of the "Cataract" (*vide* "Bourne on the Steam Engine").

Diaphragm Regulators.

Fig. 534 illustrates this retarding mechanism as manufactured by G. Jennings and some others; but, instead of its being done by the use of a rigid piston, it is here a flexible one (see D); F is the end of the lever, E the valve-spindle, B the relief-valve to allow the diaphragm to pass one way without hindrance, but which afterwards closes, and so allows the valve to close accordingly as the pass or regulating cock H is opened.

Fig. 535 is a view showing the valve open, and the regulator depressed; the arrows at B D illustrate the water passing from below the regulator to above.

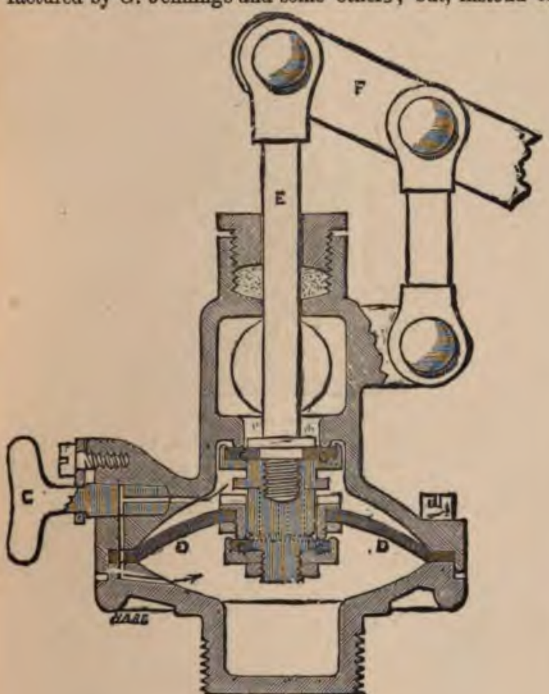


FIG. 534.

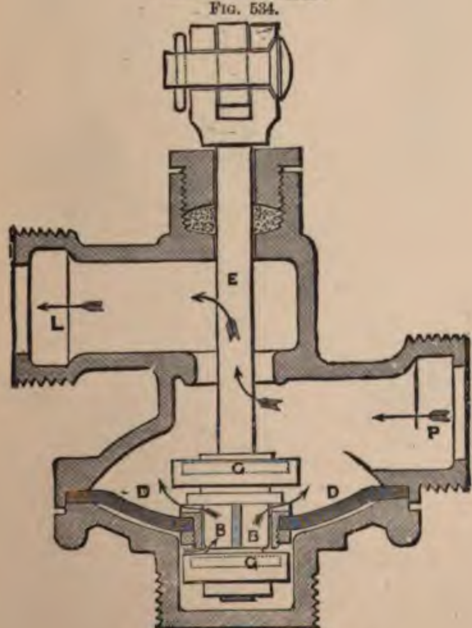


FIG. 535.

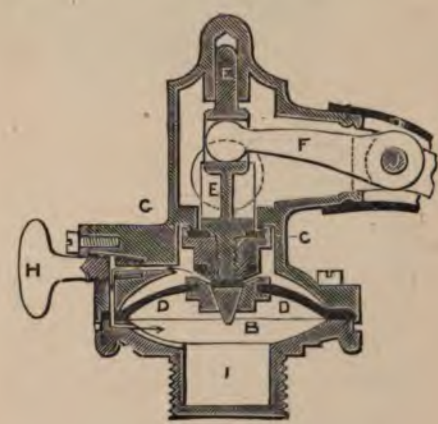


FIG. 536.

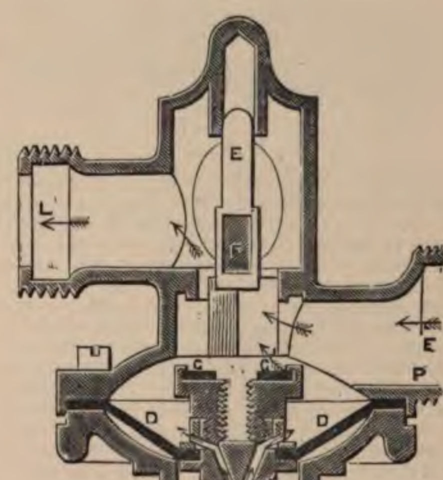


FIG. 537

Fig. 536 illustrates a side view of the valve worked by the lever F, having a flexible rubber shoe or legging, instead of the stuffing box, and Fig. 537 is an end view of the same.

Now, as I am speaking of regulators, I cannot do better than to describe one or two of those now in general use. I will commence with the well known bellows regulator.

The Bellows Regulator.

So far as reliance is concerned, this closet-valve regulator is unquestionably the best yet introduced; it is simply a lantern bellows, with copper, or other metal casing, as shown at Fig. 538. P is the casing, L the bellows fixed round the top of the casing; the action is, that the raising of the handle P, Fig. 545, or N, Fig. 266 (whereon is fixed a spur) brings up the valve-lever W, Fig. 545, and, with it, the rod of the bellows J, or B, Fig. 538.

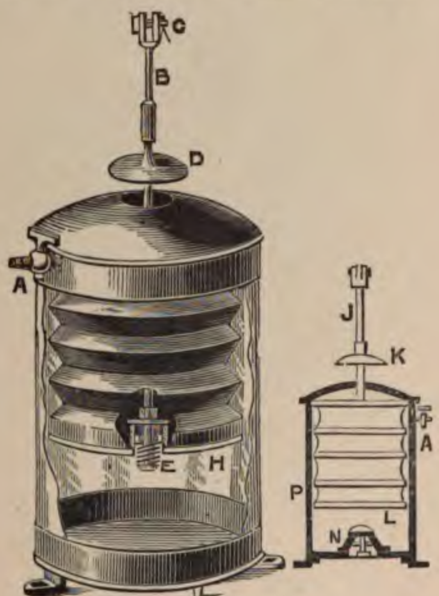


Fig. 538.

When the handle is dropped, the apparatus is prevented from falling back quickly by reason of the bellows expanding and displacing the air from within the casing, in proportion to the opening of the regulating-tap, A A. It is not unusual to make these bellows to take in the air through the regulating-cock, instead of expelling it, but, under any circumstances, the same end is attained—that is to say, the lever with valve is allowed to close slowly. In handling this regulator do not apply too much pressure upon the top of the spindle G, for this is apt to strain or burst the leather, which will be known by the sudden descent of the spindle; or if the bellows is perfect, and the spindle should drop, perhaps the valve E is stuck up, or a hole in the casing. Should the spindle stand up when the cock A is closed, the regulator is a good one; but should the spindle fall when gentle pressure is put on its top, and the cock closed, it is not a sound regulator. J K is the old regulator with the valve N in the bottom, instead of being at E in the large diagram.

Oil Brass Closet-Regulators.

Thoroughly practical men, I am sure, will agree with me when I say that I cannot recommend these regulators, inasmuch as where oil is used as a lubricant, it very soon becomes cloggy, and even glycerine will not be found a good lubricant for any length of time, though it is far better than common oil, more especially in the winter season. A, Fig. 539, is the cylinder, within which the piston, D, works. On raising this, air gets below J, and when the lever or rod is depressed, the bucket J of the piston expands, and so keeps the valve-lever from suddenly falling; but, by opening the regulating-screw C, the in-

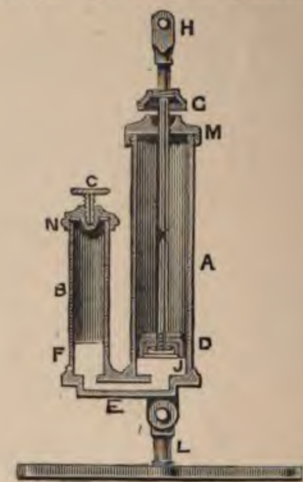


Fig. 539.

closed air is released, and, in proportion to the opening, so the piston, with the closet-valve, is allowed to fall and close the seating. This kind of regulator is shown at Fig. 540, as generally fitted to a stool-valve on an iron frame

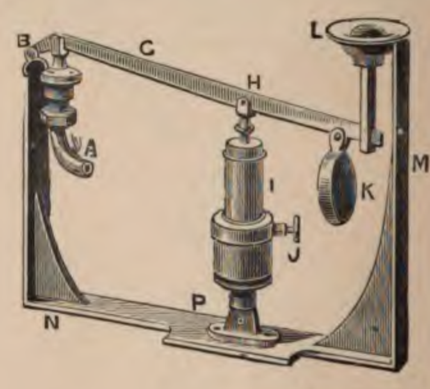


Fig. 540.

Fig. 541

M N, in damp places, where the bellows are likely to decay. J is the regulator. In such situations glycerine (or quicksilver) should be used, instead of sweet oil. There are several makers of these regulators in London, but Underhay was the first to make them, and which he patented. His pattern has a hollow or tube piston and only one tube, as at A, Fig. 539. [See P Q, Fig. 262, and Fig. 485, &c.]

Cottage Closet-Valves with Diaphragms.

These valves will be shown at Figs. 541 and 542. Fig. 541 has the supply-pipe to come from below, and be connected at I, which, in many instances, will save a bend, as also some lead piping. Fig. 542 shows the valve, having the inlet on top at I; this will be found very suitable in cases when the pipe has to be run down the left-hand side of a W.C., and will also save a double bend.

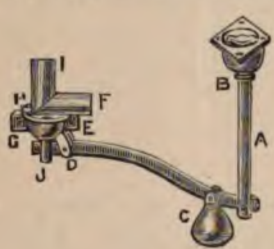


FIG. 542.

These closet-valves, however, as generally made, are very objectionable, for exemplification of which see Fig. 543; this is the cottage closet-valve, with diaphragm in section. I is the inlet, F the outlet, and M the brass part of the valve, to which is fixed the indiarubber H. This valve, in order to keep it perpendicular to the seating, has a guide-nut, T, having spurs or feathers, [see P Q R S, also N T]. This blocks the water-passage, and often to the extent of three-fourths of the water-way, so that it is simply absurd to use an inch valve in connection with an

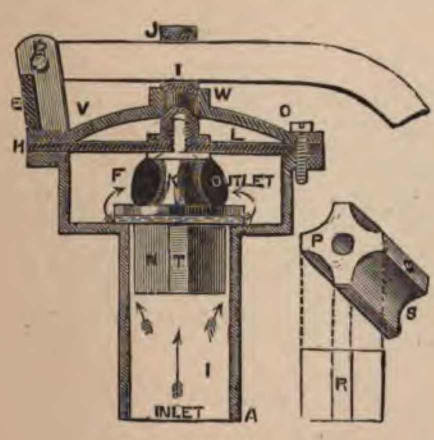


FIG. 543.

inch pipe. Such a valve as the one illustrated should, therefore, never be used. These valves though, be it understood, are capable of improvement; for instance, instead of using the feathered nut, as shown in the diagram, and commonly made for these valves, let the top-plate V, just where the spindle enters at W, be made, as shown, longer than those at Figs. 544 and 545; and so let this guide and steady the valve. There is no reason why this should not be done.

Hopper Closets and Water Supply.

[*Also see Servants' Closets—Servants' Closets (position of).*]

We have now arrived at the class of W.C. that has been beyond doubt very much neglected, so far as the water supply is concerned, for the simple reason that careless persons will argue that it is only a servants' closet. This argument, however, presents no valid reason why these closets should not be flushed as thoroughly and perfectly as any valve-closets, inasmuch as though they may be in a part of the house not frequented by the upper members, they nevertheless must, if imperfectly arranged, affect the sanitary condition of the house; for wherever foul gases are allowed to escape they must permeate more or less the whole atmosphere throughout the building; and, in fact, if there is to be any difference the servants' closets in the basement should be the most effectually flushed, as foul air (excepting carbonic acid gas) always rises, not descends. A further reason why the hopper closet should be best flushed is, that the best or valve-closet will work properly if the water is allowed to flow into the basin through an only eighth of an inch pipe, because the basin of the valve-closet quickly fills up by the dribbling income of water, and on opening the large bottom-valve this accumulated water will leave the basin in body, and with a force equivalent to that acquired by throwing down a good pailful of water. Now with the hopper valve quite the contrary is the case, as such feeble, and I may say, inadequate supplies are almost useless; in short, the water should be supplied through a pipe in proportion to the head and valves selected, caution being used to prevent their closing too quickly. I have called attention to this in a former part of my work.

An examination of Fig. 544 will show you the old-fashioned hopper closet basin L, with a diaphragm cottage-valve V, fixed to a wooden block or brick in a wall; as a rule, these basins are fitted with a ½in. supply-pipe, and ½in

FIG. 544.

valve, and with the water supply from a cistern not more than 5ft. or 6ft. above the closet floor-line; such supplies as the above are nothing more nor less than shams. The pipe should be at least 1½in., and a clear way-valve without sharp bends for such heads of water. If the head was multiplied by 15, then a ¾in. pipe with ¾in. full way valve would answer, because in this case you would get a good weight or pressure of water.

Fig. 545 is the cottage-valve V, screwed on to the back-board E; this valve is also shown fitted with the regulator

R, which allows the valve-lever to fall slowly. To guarantee the proper working in such instances, it is essential that a proper pull should be selected for this description of levers; —*i.e.*, a pull having a long slot for the lever to work through, as illustrated at Fig. 545, also at 553, 563, 540, the end view of which is shown at R, Fig. 555. This allows the lever to drop down without the possibility of its pressing the lever downwards.

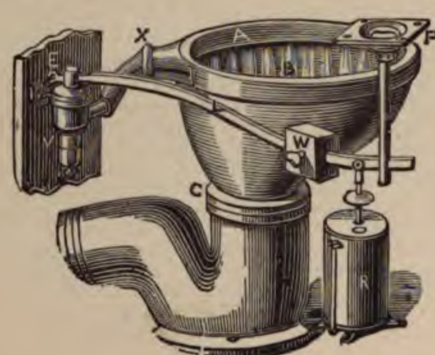


FIG. 545.

Cause of Closet Valves Leaking.

In fitting the lever to such pulls as these there is one point to be noticed—namely, that you should never allow the lever to rest upon the bottom part of the slot, because if it is allowed to do so the valve cannot properly shut. In proof of this, in the event of the valve allowing the water to run or leak out, examine the lever, and, in many cases, if not most, the above fault will be found the cause. The fault, however, not unfrequently arises from a deposit of lead shavings or solder being deposited in the valve in which, if you take off the top of the valve, you will find the deposit in the seating of the valve; to remove which allow the water to run freely for a little time with the top off, but not so as to spoil a ceiling below.

Sometimes these valves will leak if the lever does not bear fairly upon the centre of the spindle; at other times they will leak if the lever rests upon the spindle or stem of the regulator; at other times the valve will let by if the spindle should get bent, or the rubber perished, &c.

Flushing Rim and other Hopper Basins.

Be it most distinctly understood that no matter how good may be the pipes and valves used, unless the spreading arrangements within the closet basin are properly constructed—that is, so that the water shall spread over the whole surface of the basin—that the basin cannot be expected to be kept clean. There are many methods invented by various manufacturers for arranging this most important point, and most of them are generally effective if properly fitted, and to a great measure the responsibility of this will rest upon the workman's judgment of selection and fitting up.

The first introduced was the fluted oyster-shell pattern, next the old leaden spreader, cut to the shape of half an ellipse; at other times to the shape of a semicircle, as shown at Fig. 546 [see the closet basins in Figs. 490, 491, 565, 566, &c.]; after this came into use the flat vertical slot sending the water spinning round the pan; then the copper spreader, tinned over; then the fan with the long screw; then the fan, nut and union, Fig. 546, but now quite out of date.

After this the flush rim, which allowed the water to run out in small streams, as shown at B, Fig, 545, 411, &c. Last, and not least—for I consider it the best—is the fan or lipped flushing-rim, as shown at K, Fig. 547, also at B, Fig. 548. These basins are a great improvement, and possess considerable advantage over those requiring the lead or copper spreader, inasmuch as if the water supply is

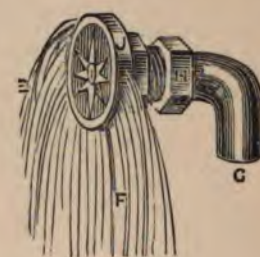


FIG. 546.

plentiful (as of course it should be), the basin will be thoroughly washed, as shown at Fig. 549, and candidly, I fail to see the want of any better closet. Fig. 413, at C, illustrates a basin fitted with a copper spreader, but which is also made with flush rims.

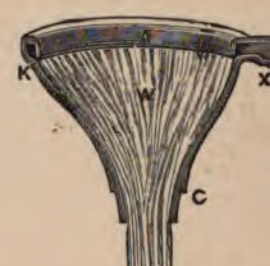


FIG. 547.

If you again examine the basin, Fig. 547, it will be easily observed that the water coming from the fan or lipped-rim sends a thin layer of water completely over the surface of the basin, and that this layer becomes concentrated. It is very easy to estimate the value of this basin when you consider that at the point of the fan the water is ⅛in. in thickness, and that as it descends to where the soil is likely to be it gradually concentrates to a thickness of ⅜in., and finally to ¾in. During the last twelve months I have fitted up a great number of this kind, and have found them invariably to act in the way here described.

Lipped Basin.

This is shown at Fig. 548. It is a basin having a lip D, which throws back the water from the front of the basin, and upon the spot where the soil is likely to stain the back part of the closet basin, but this basin is not made as I should like to see it; the hollow below the lip should be filled up so that it could not become a dirt receiver.

FIG. 548.

Basins and Traps in One Piece.

Seeing that there are some hundreds of closets that might be and are included in this title now in the market, I shall only bring two or three of the most prominent before your notice. Fig. 413 represents one of, if not absolutely, the first made, and is a very good one for the reason that the

FIG. 549.

basin is so constructed that there is always a layer of water for the soil to drop into, which to a great extent tends to prevent the accumulation of soil on the basin. Fig. 550 is

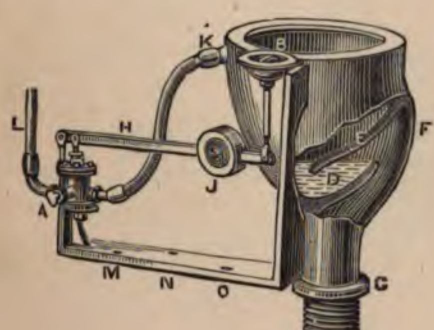


FIG. 550.

a kind of lip-trap basin. E is a diaphragm which dips into the water, D, and so forms a very compact trap; A is the supply valve fixed upon a floor bracket or frame; K is the connecting pipe from the basin to the valve.

For these closets and traps in one piece, also see Figs. 488, 575, 576, &c. I hold that every time a water-closet is flushed, it should be in such a manner that the inflowing water will rise, and for a moment, stand full bore to about 4in. to 6in. up the inlet or dip pipe, and above the normal water line in the trap. This is sure to empty the basin and trap of their contents, and will well fulfil the all-important purpose of flushing the drains every time that the supply to the closet is brought into action. To compass the desired object, we must have all traps and fittings in accordance.

The Carmichael Closet.

For the illustration of such a closet, refer to Fig. 551. This is Buchan's basin and trap with water supply spreader combined with special flushing jet. The combination complete is known as Buchan's Patent "Carmichael" wash-down accessible closet. This gentleman, who is a Scotch plumber, has after many years' working, brought

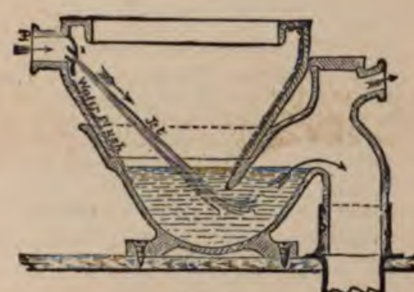


FIG. 551.

out what may be called the acme of hopper closets. The water enters at the inlet arm, when a portion of it passes directly out through the jet tube 1. The water jet thereby produced submerges and sends off the paper and fæces, when the rest of the water is induced by the spreader to flush round each side of the basin to its front, when the whole body of the water then rushing down fills up the mouth or entrance side of the trap, and so the level of the water within the trap is seen to rise in the basin as high as the dotted line. With the Buchan jet properly directed, as at *Jet*, Fig. 551, or by the use of the brass flap spreader, the soil may, like dirt before a broom, be swept away under the throat of the trap as shown by the arrow.

Household Closet. (Direct Action Closet.)

This is shown on the left hand side of Fig. 552. The advantage claimed is that the water in the trap comes up to the bottom of the basin, which being of a short character, there is not much length of pipe to become fouled on the inlet side of the trap. This closet is a very good, simple, and inexpensive servants' closet.

Brazier & Sons' Direct Action Closet.

This closet is shown on the right hand side of Fig. 552, and which has come under my notice since writing on Ward's closet. Brazier's closet is ventilated, and is shown elevated, and screwed upon a block, and is everything that can be desired for a servants' closet if properly flushed with water.

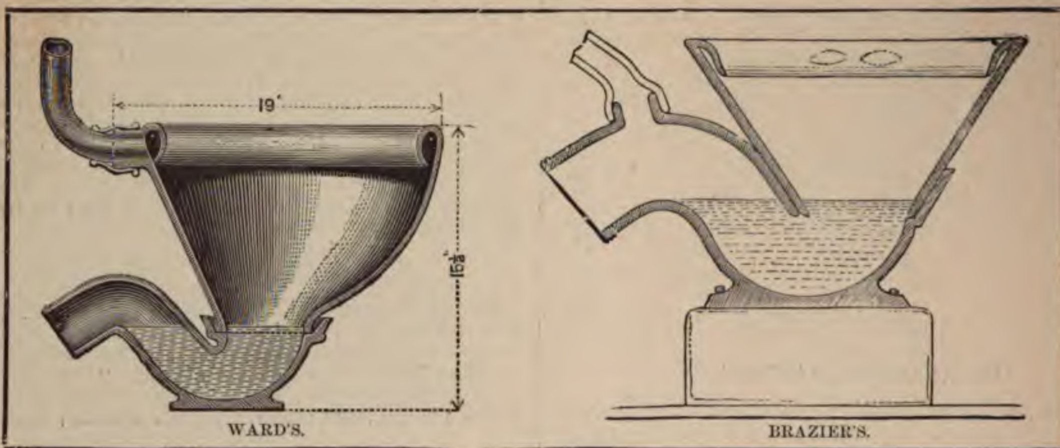


FIG. 552.

(*Brazier's Closet continued.*)

In this closet the surface of the water within the trap is brought very close to the seat, and being wide across, the closet is made to resemble the valve closet more than the direct action closet, and the consequence is that it cannot very well become fouled.

Seat Action Closets (Valves below Seat).

These closets are shown at Figs. 553, 554, 555, 556, 557, 564, &c.

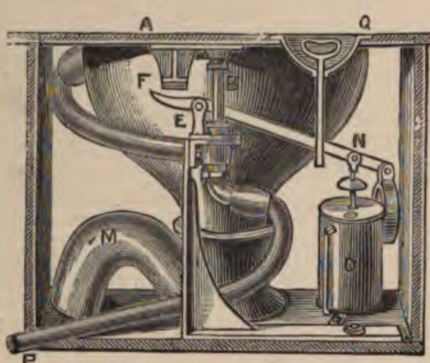


FIG. 553.

Fig. 553 is simply a stool-valve, having the lever end lengthened as at E, the seat being hinged at the back in such a manner that it will fall about 1in. at the front with pressure. On sitting down upon the seat, the stud or spur F obtains an extra pressure upon the end of the lever, and brings up the other end N, and with it the valve B, and the stem of the regulator O, when the water runs continually unless it is fitted with a waste-preventing valve, as described and illustrated at Figs. 561, 562, 563, 564, &c. Should this seat be fitted with a waste-preventing valve, it is often desirable to fit the dish and pull Q, so that it may be used to flush during the time the closet is being used; but the handle must be of the slotted kind, to allow the lever to rise without the handle or pull. See M R, Fig. 555.

Fig. 554 is a seat-action valve somewhat similar to that described above, but is fixed upon the backboard V, or it may be fixed upon a strong riser (the board in front of a closet seat), or on a half-frame, as at Fig. 553. This

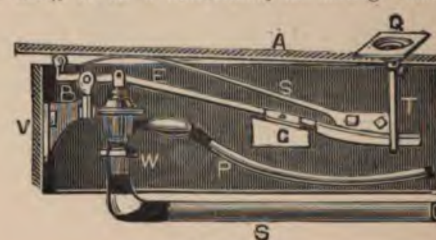


FIG. 554.

valve is one that will continue running as long as the seat is occupied, but of course a waste-preventer may be used, in which case the dish and pull Q should be fixed, as in Fig. 553.

In the diagram Fig. 555 is shown a seat-action waste-preventing valve,

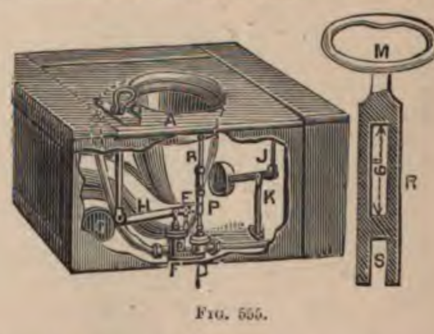


FIG. 555.

venting valve, the seat of which, when pressed downwards, first shuts off the inlet valve D, then opens F, but on rising from the seat, the valve D opens and the valve F slowly closes after a given time, so that to a certain extent this is a waste-preventer. The lever H should work through a slotted pull, as shown at R M S, so that the lever may be allowed to rise without the pushing up of the pull.

Seat-action Pan Closets.

For this refer to Fig. 556. All that is required in this is the ordinary lever lengthened and the standard added, as at B; this is often fitted without thought. It is exceedingly bad, inasmuch as the copper pan remains open during the time that the closet is in use,—the water being allowed to run continually during the time the closet is in use.

FIG. 556.

Fig. 564 illustrates Common's Patent Seat-action Water Waste Preventing Closet Valve, and, as may be seen, is worked from the end of the lever as at F; for further description see the particulars there delineated. [*Also see* Fig. 651 for Seat-action with Cistern.]

Door-action Water Closets

There are a great variety of methods for fitting door-action closets; but in point of fact, though many plumbers make a great fuss when fixing them, there is very little more to be studied than in fixing a seat action closet, and it will be readily seen that either may be fitted to the other. Fig. 557 illustrates a very simple method of connecting the

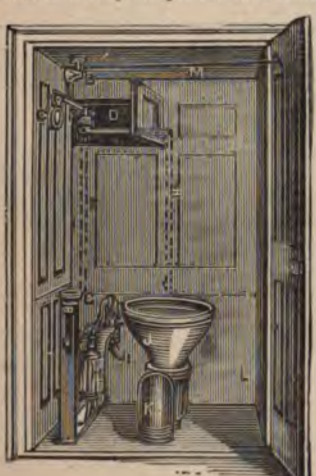


FIG. 557.

door A to the crank B, which crank is in its turn connected to the cottage-valve D; this valve may be fixed as shown, or under the closet-seat L, or in almost any other position. It will be seen that, if the door is pulled open from the outside, that the wire M will pull the crank B, and work the valve D, and as long as the door is kept open will the water continue to flow, unless the valve is of the waste-preventing description. Of course the valve can be fitted with a regulator or other retarding mechanism at P to keep it open for any given time. [*See* D K, Fig. 503.]

I cannot say that I am much in favour of door-action closets, although fitted in a sanitary point of view, seat-action being the preferable, and therefore, when executing contracts of the door-action kind, endeavour to fix an additional pull-up valve as at G, Fig. 558, which allows the user of the closet to flush the pan of the closet during the time it is in use; or if the extra pull is too much expense, I fix a pull to work the door-valve, as shown at K G, Fig. 557; S, Fig. 558; H, Fig. 559, &c.

Fig. 558 is a diagram of a door-action closet with the door opening inside. This arrangement is effected by

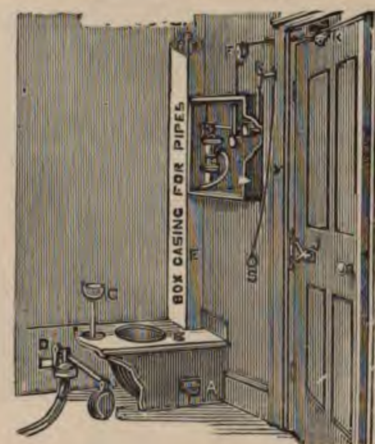


FIG. 558.

fixing a pulley-wheel on the top part of the door-frame or lintel of the door, and with a chain connecting the door to the lever of the valve Q, as shown. This valve is also provided with an extra pull as at S, and an additional valve at C D, or the valves may be actuated by the use of a treadle or pedal as at A.

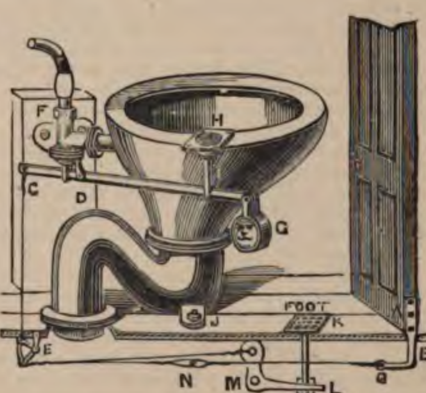


FIG. 559.

Fig. 559 illustrates another door-action closet, the door of which may be made to open either inwardly or out-

wardly, by fixing the cranked pull B as shown at Q to point inwardly to the closet, and at right angles with the door. This, however, may be varied to suit circumstances. This valve may also be worked with a slotted pull-up pull H, I, or by treadle arrangement as shown at K, or by opening the door, or otherwise.

Pedal-action Closets.

Fig. 560 illustrates Terry's Pedal-action W.C. made by Tylor & Sons; also a pull as at A. The pedal is fitted to the riser of the W.C., and is so arranged that the pedal lever will lift up the lever of the valve or pan-closet exactly in the same manner as the closet-lever does the valve lever

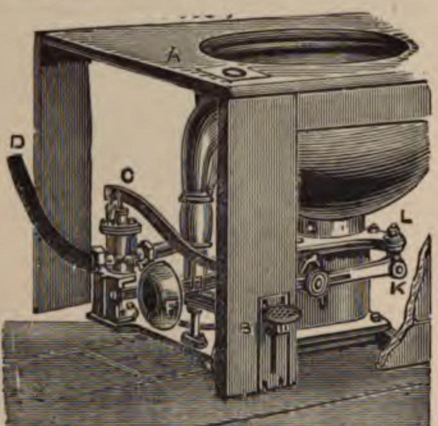


FIG. 560.

of the water supply. This treadle is also made to allow the lever of the closet to fall, notwithstanding it is kept pressed down, so that it becomes a waste-preventer. Fig. 558, and also Fig. 559 and Fig. 560 are pedal closets.

Water Waste Preventers.

[*For fixing below seats.*]

The waste preventer, known as "Tylor's," is illustrated at Fig. 561, and works as follows:—R is the inlet; D the valve-seating, P the outlet, B the top part of the valve, H the indiarubber washer, X the screw, with a diminishing or cone-shaped head, which, by the way, answers two purposes, viz., as a screw to hold the washer, and as a reducer for the flow of water through the valve-seating before the valve returns, and finally rests upon the seating. A is the regulating screw-valve or cock, to prevent the valve remaining too long open after the handle is dropped; it also prevents the too sudden closing of the valve, as illustrated at Figs. 530, 531, 533, 534, &c. Assume the valve G to be at rest upon its seating D. Raise the lever, 2, which will, as exemplified, bring up the spindle T, and the cylinder or socket E, with it also the loose piston B CH off the valve-seating; but, by reason of the slackness of the fit of this piston, it allows the water to pass between its sides from below to above, or into the top of the cylinder E, and in proportion to its size and the amount of fit within these parts, or the distance travelled, so long will the water continue to flow at each upward movement of the lever. My personal experience in the manufacture of these valves led me to make the plunger as large as possible, and to fit easily, which allows for oxidation, which, after a short time rests, and the piston valve will work well, but if at first it is made to fit too tight, it chokes and sticks fast, when it must be taken out and cleaned with fine emery paper or powder. Of course such choking is caused by the furring in different waters.

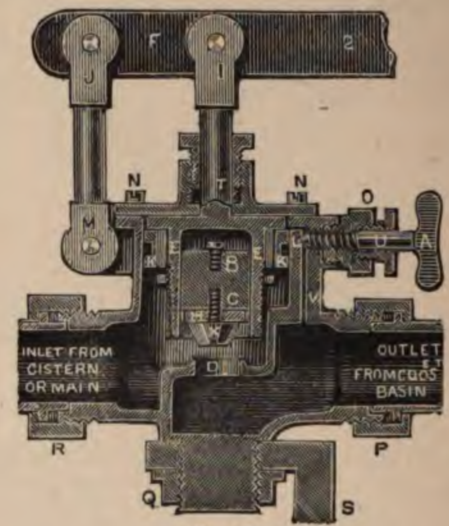


FIG. 561.

The next of these self-closing valves is illustrated at Fig. 562. It is simply two diaphragms known as Lambert and White's patent.

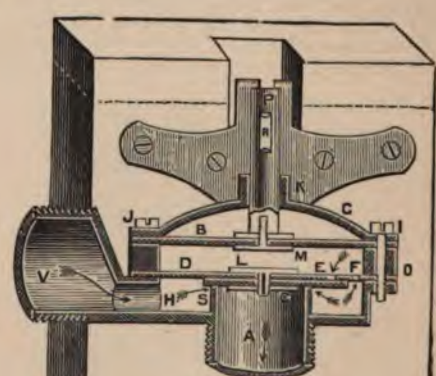


FIG. 562.

Diaphragm Waste-Preventing Closet, Cottage and other Valves.

Fig. 562 illustrates a double diaphragm waste-preventer valve. The outlet valve here at S G is an improvement over that shown at N T, Fig. 543, inasmuch as the feathered nut is here in Fig. 562 dispensed with, and the spindle made to work through a guide in the top. To understand the action note the following particulars: Suppose all to be

full of water, *i.e.*, between D, H, A, V, &c., V to be the inlet, and A the outlet; then pull up the spindle P of the top diaphragm B; this, by reason that the water is between the two diaphragms will, so to speak, suck up the other diaphragm D, thereby opening the valve attached, when of course, water will run to the W.C.; but by reason that there is a small hole F in the bottom diaphragm, and that this diaphragm has a weight at L, the water will run up through the hole F, and allow the diaphragm D with the valve S to descend slowly, and again cover the seating; this happens notwithstanding that the lever and top diaphragm are being held up. The bottom diaphragm can be steadied from fluttering by working it with a spindle and bridge or piston and cylinder, or as shown at L, Fig. 635.

with the stream, no matter in whatever position it may be fixed. This is due to the fact that the induced current has great influence over the valve regarding its closing.

This valve may be had fitted with regulators, as at D D, Fig. 535, or may be fitted with the ordinary bellows regulator, &c.

Single and After-flush Water-waste Preventers.

Lambert's valves are also made to give single and after-flush supplies of water as required. Fig. 563, on the left-hand side illustrates the valve made as a single flush

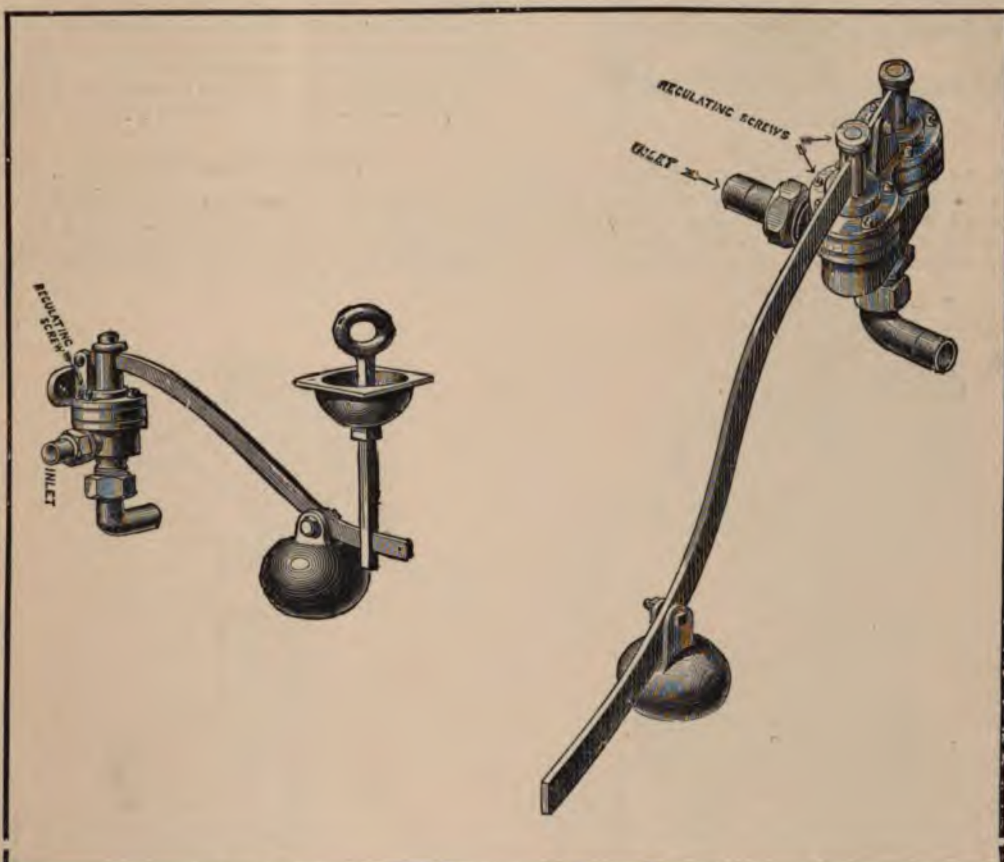


FIG. 563

Suppose such an action to have taken place, and drop the lever, the top diaphragm will fall and send out water from between the diaphragms through the small and simple relief-valve E, which opens downward; the arrows indicate the direction in which the water rushes during the time the valve is in action—*i.e.*, during the upward or downward motion. I may add that this valve will close

valve, and that on the right-hand side both single and after flush, viz., that on pulling up the handle a distinct flush of two gallons is obtainable, but no more; but when you let fall the pull, another distinct flush of two (or other regulated quantity) gallons is obtained.

For single and after-flush double valve water waste preventers, see Figs. 616, 623, 624, 641, 642, 651, 652, &c.

Common's Valve Waste-Preventer.

Fig. 564 illustrates a waste-preventing seat-acting closet. After what has been explained, the parts will be readily understood. On depressing the end of the lever F, it first

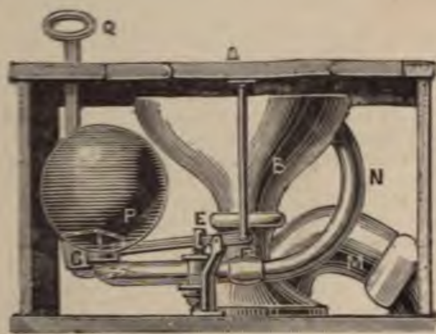


FIG 564.

closes the large valve leading from the air-chamber P to the basin (or the small valve from the supply-pipe); it next opens a small valve from the main supply, which allows the water under great pressure to enter the ball or air-chamber, when it compresses the air within, and, so to speak, becomes full. Now take the pressure off the end of the lever, and allow the small or inlet valve to close and the large valve to open, the compressed air within the air-chamber will then force out all the water through the large valve and into the closet basin. This valve is very much used about the neighbourhood of Brighton. [For section see Fig. 666.]

Twin Closets; also Fixing and Wiring Closets.

A reference to Fig. 456 will show the traps and pipes to be fixed to twin closets, and Fig. 565 illustrates the two closets as fixed, at CHILDREN, ADULTS. Both these closets are supplied with water through service boxes and submerged valves, from the cistern above. When such valves are used they are generally actuated by means of a strong copper wire, C W, $\frac{1}{8}$in. in diameter, and by the use of the cranks B A; also the ball lever D, which answers, as its name implies, as a lever, to change the direction of the wire, and as a weight to bring up the wire. When fixing these closets it must not be overlooked that it is essential in all cases, without exception, to fix them over a proper lead safe, M, fitted with a good overflow pipe.

Bedding or Setting Closets.

Though to some experienced hands in the trade it may appear superfluous, it is necessary to remind the younger ones that it is very requisite to use great care when bedding down, or as it is better known in the trade, when setting the

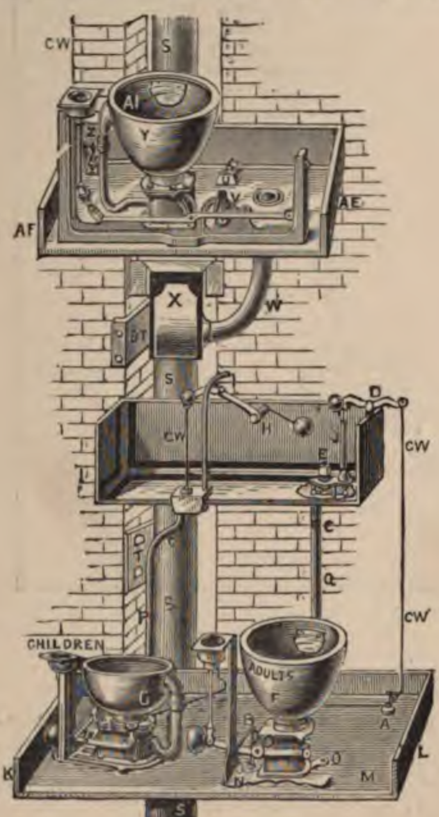


FIG. 565.

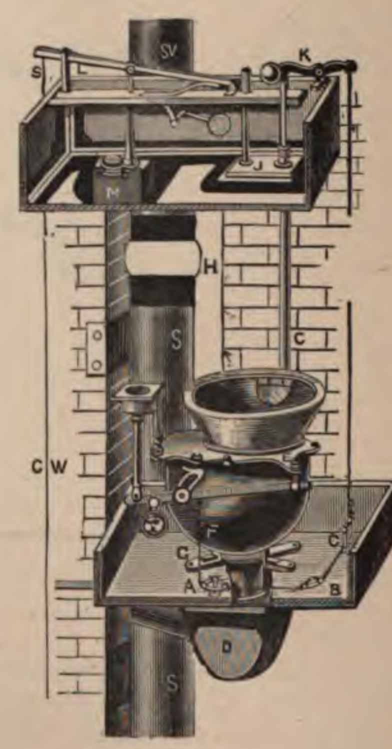


FIG. 566.

closet, so that, when screwing it to the floor, the bottoms of the lugs and lead work are well painted before the putty is applied; also that the closet must be properly bedded on good putty before the screws are put in. In the upper part of diagram 565 is shown a Bramah closet fixed over a ᑌ-trap, and there is also shown the old method of fixing the overflow of the safe into the side or cheek of the trap. There are plumbers even to this day who adopt this style, and I think that they are in this point decidedly in error if fixed for permanent work.

Fig. 566 is a diagram of a pan closet as fixed over a ᑌ-trap. This kind of closet I have long since condemned, but as there are thousands of plumbers who think otherwise, and will insist on fixing the old pan-closet, I, as before stated, deem it almost a matter of duty to apprentices in the trade to describe the proper method of fixing them. Some of my readers will probably more easily recognise this diagram under the title of "wired closet," which means that the valve in the cistern is actuated by the use of a wire C W (closet-wire). The cistern should be lined with 6lb., or, better still, 7lb. lead, and the valves fixed over a service-box properly wired.

Wiring and Cranking Closets.

The best method of doing this is to fix the cranks so that they may pull in a line one with each other. Use side cranks, M A, Fig. 568, for changing horizontal directions, as also at B, Fig. 566, and upright cranks W X, Fig. 567, for changing the pull-line from a horizontal to a perpendicular, as shown at A, Figs. 566 and 565.

Fig. 567.

Fig. 568.

Fig. 569 shows the method of fixing cranks to a pan-closet without the use of a side crank, and which gives underhanded motion. P is where the power is applied from the lever of the container, and W the end working the weight. It will very readily be seen that if you pull up the first crank at A, that this power will be communicated to that corresponding point of the second crank C, and affect whatever is at the end of the wire W. Now suppose you cannot go in a straight line with the wire W, but have a wall to pass through, as at Q, Fig. 570, you must, under these circumstances, connect the wire W, Fig. 569, to N, Fig. 570. In this case the crank is shown to work back or

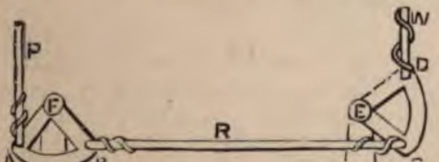


Fig. 569.

with crossed wires, which allows the wire N to work close up against the wall E. Here notice the difference with the crank H. M G, as it is now fixed, throws the wire F at least 6in. away from the wall, and is a clear indication that the person who fixed it did not know his business.

The proper way to fix the foot of this crank is lower down at about S, so that the wire may pull from above the rivet line or about T, which would throw the crank to work backwards as at K J I, and thus allow the wire to come near the wall.

By turning Fig. 570 upside down, and joining F on to P, Fig. 569, the whole of the work may be reversed. That is, pull at N, and you actuate W, Fig. 569, and by turning Fig. 569 upside down, you at once get an overhead motion, or in other words, pull the wire, and you actuate W. The above is the method of fixing cranks to the bottom of joists or ceilings, and will answer in situations where ball levers cannot be employed. Of course, in instances as

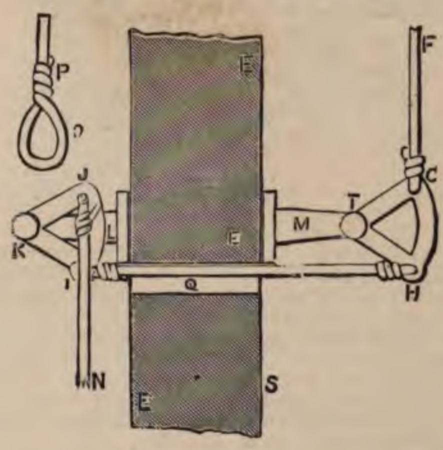


Fig. 570.

here described, a weight must be fixed on the wire W to draw the wire back, or a check-spring may be employed.

In the selection of cranks it is always necessary to see that they are not put together with an iron rivet; they must be brass and work loosely.

If by any chance they have become clogged up and stiff through the use of c", place them over a moderate fire and so burn out the oil, but remember that if you put them over too hot a fire you will most probably melt the rivet.

Wiring Closets, Fixing Regulator Closets.

The first thing after having run the cranks is to do the wiring. It is a very general thing with good tradesmen to fix the wires as they proceed with the cranks, and in many cases it is, no doubt, an advantage.

Before attempting to fix a length of wire, first secure one end to a nail or any other fixture, and with the pliers stretch the wire as much as possible, that is, without injuring the wire. It will, of course, be understood that a pair of good cutting pliers are indispensable. When at this work myself, I always use two pairs, one for holding the wire near the link, and the other for twisting the wire. A very little practice will teach you the extent of tension to put on the wire when stretching it. The pliers are shown at Fig. 686.

When making the links, see that the end of the wire used to twist round the main wire is truly turned, and each turn true with the other, cutting off the end close up to the twist, as shown at P, Fig. 570. Do not leave it in the slovenly manner shown at W D, &c., Fig. 569.

Under certain circumstances you will require links formed in the wire, as shown at K L, Fig. 446. This should always be done between the first crank and the lever of the container, as shown at F A, Fig. 566. It is quite as well to place a link between the ball-lever and the

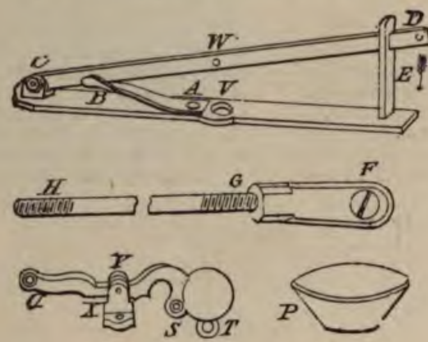


Fig. 571.

crank in cistern work, as the ball often drops more quickly than the valve, and thereby bends the wire. The cause of this is very simple, viz.:—that a weight falls through a given space of air much more quickly than through the denser matter water; the necessity for placing the link between the first crank and the lever is that, not unfrequently the lever gets quickly pushed down before the ball-lever can drag up the wire; remember always that that which gives action necessarily moves first. The long link is illustrated at L Q K, Fig. 446.

T, Fig. 571, is the ball-lever as fixed at K, Fig. 566, and D, 565. Always fix this lever to pull the valve "plumb"—that is, not out of the upright. Levers should be made as they were originally with brass standing lugs Y, as when made of iron they rust and become stiff in action.

Spring Boards.

At A B C, &c., Fig. 571, also at SPRING-BOARD Fig. 592, is illustrated the spring-board for actuating the spring-valve, as shown at L, Fig. 566. A B, Fig. 571, is the spring, C the joint, D the lever, E the guides, H F G is the rod and sling; on the rod is cut a long screw, which screws into the eye of the sling, in order to lengthen or shorten according to circumstances; at H is another screw which screws into the socket-link of the spring-valve. The manner of fitting the spring-board is by fixing it over the top of the cistern, so that the hole V in the board is vertical over the spring-valve link, and the end of the lever D turned to suit the proper working of the wire; the sling of the rod couples the rod to the lever; the rod and sling should be ordered to suit the depth of the cistern, with plenty of screw for the sling to allow for cutting off if necessary. P is a diagram of a copper-pan for a pan-closet: these pans are sometimes spun and at other times hammered up. The latter are most to be relied upon for good wear.

Fixing Regulator Closets.

Fig. 572 illustrates one of Underhay's Regulator Pan-closets, fixed over a Ʊ-trap; the safe overflow runs into the band of the trap; the proper plan is to cause this pipe to deliver over a head, as shown by the pipe O E. R is the bellows-regulator, made with zinc or copper: those of copper are, of course, much the best for durability.

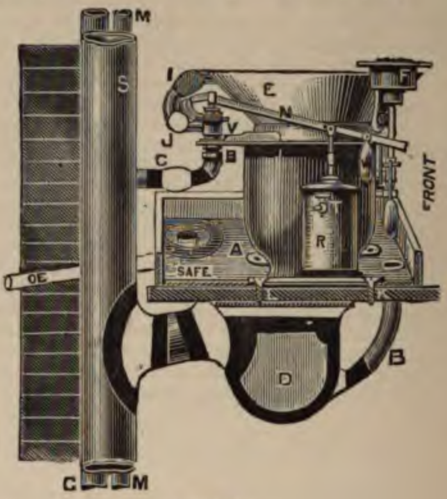


Fig. 572.

Closets, &c.

The diagram 573 illustrates a valve closet, fixed over the half ᔕ-trap. This kind of closet, above all others, *never* should be fixed over this kind of trap, as the momentum of the water in passing from the valve of the closet entirely destroys the water-seal of the trap, which necessarily

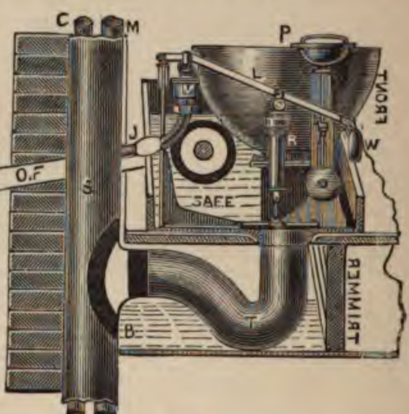


Fig. 573.

renders the trap totally useless. Under all such closets a properly-constructed Ʊ-trap is the only one at present invented that will prove thoroughly efficacious under all circumstances, viz.:—taking siphonage and momentum into consideration.

Proving Closet Flushing.

I have said that all closets should have an ample supply of water, so that every part of the basin may be thoroughly washed, more especially the front part. A very excellent

method for testing the efficacy of the water flushing is to dry the basin by partially opening the closet-valve or copper pan, and then painting the basin *all over* with a good coat of plumber's soil; then, in the ordinary manner, pull up the handle of the closet, and if any part of the basin is not cleaned, the flushing is not perfect.

In order to avoid such a contingency, it is necessary, first of all, to have a proper-sized pipe and valve, and by all means do not make any very sharp bends or a lot of branches. When you are so circumstanced that you are compelled to have branch joints, you should always make them at the easiest possible angle.

By adhering to the following instructions (which will, in most cases, be found a very good workable table), a very effectual flush may be relied upon for a closet supply. When the head of water is 5ft., use a 1½in. *full-way valve* with the same-sized pipe; but when the pipe has to be taken in a horizontal direction, in all cases use the next size larger to allow for friction. When the head of water is between 5ft. and 30ft., use 1¼in. full-way valve and pipe; though if the pipe runs from 7ft. horizontal, use 1½in. pipe to allow for friction. Again, should the head of water be from between 35ft. and 60ft., use a 1in.; and, in my opinion, nothing less than a 1in. valve should be used, although in cases where the height is from 60ft. to 80ft., a ¾in. pipe may be used; but larger, according to whatever length of horizontal pipe there may be. A sharp bend will retard the flow of water to at least half; therefore make the bends as easy as you can. Perfect flushing also depends, to a very great extent, upon the kind of closet-basin used.

In my estimation, Sharp's pattern, which I have before spoken of, and known as the flushing rim, is the best. In using this basin, care should be taken to prevent any dirt or other foreign matter getting into the rim, as it will prevent the water passing all over the basin, and consequently leave it only partially cleansed.

Servants' Closets Upstairs.

[*Also see Hopper Closets and Water Supply, Servants' Closets, Position of, &c.*]

From a sanitary point of view, and assuming always that they are properly flushed, these closets, as shown at Fig. 574, &c., are very good, and as there are not any working parts, everlasting; all that is required is a good trap and hopper, or a cottage, or balloon-shaped basin (Sharp's pattern). I deem it best to fix these basins over a *properly* constructed lead trap, if fixed as shown in the diagram.

It is preferable, that is, where practicable, to flush these closets through a service-box or small waste-preventing cistern, having a 1¼in. or 1½in. lead pipe; but when this is not easily practicable, it is best to work from charged pipes. In such cases the valve is best fitted with a regulator, as shown at E, Fig. 574, also at Figs. 550 and 545, &c., so that it will be impossible to get a less quantity than about two or three gallons each time the handle is pulled. The parts of this W.C. are as follows: A, Fig. 574 is the closet-pan, B the leaden trap—in this case it should be a leaden trap, because it is fixed above the basement floor-line, and requires to be connected with solder to the soil-pipe S. In all cases with this kind of work it is absolutely necessary that the trap, as above stated, should be of lead, as all joints between the trap and the drains to be effective should be *soldered*, because if the trap is of earthenware, the first joint has to be made of putty, and such joints, owing to the variation of temperature, are subject to expansion or contraction as the case may be, and when it happens to be contraction they necessarily cease to be air-tight. C is the closet supply, D an Underhay's closet-valve, (this is fully explained under the head of Closet Flushing,) E the regulator, which allows the lever to fall only slowly, thereby preventing it from closing suddenly.

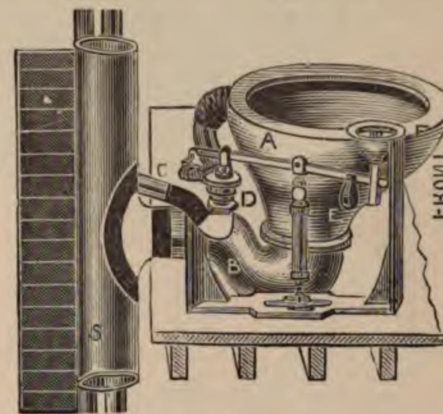


Fig. 574.

Another effect is, that whilst the lever is descending, water is continually running through the supply valve D, which when used in conjunction with either valve or pan-closets, is known as the after-flush.

Closet Basins with two Supply Inlets.

This closet is made by Bostell. The water supply is delivered through a kind of breeching piece Q, Fig. 575, which is made by bending round a piece of 1in. to 1½in. lead pipe, and making a branch joint off the main supply

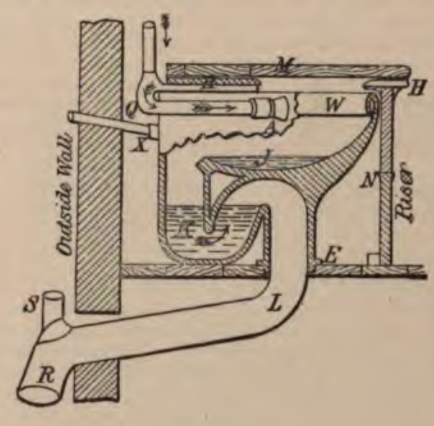


Fig. 575.

pipe as shown at Q, Fig. 576. The closet itself is similar in make to that shown at Fig. 549, and needs no further comment.

This closet is fixed like all others of this class, and is done by simply opening the pipe sufficiently wide to admit the trunk of the basin, as shown at E, which is bedded

down with red or white lead and screwed down by lugs, or the lead of this flange may be brought up and turned over, as shown at E, Fig. 576. C F is an air pipe, which also acts as an overflow pipe should the closet become choked up. In making this joint at E sometimes hemp saturated with red lead may be used with advantage.

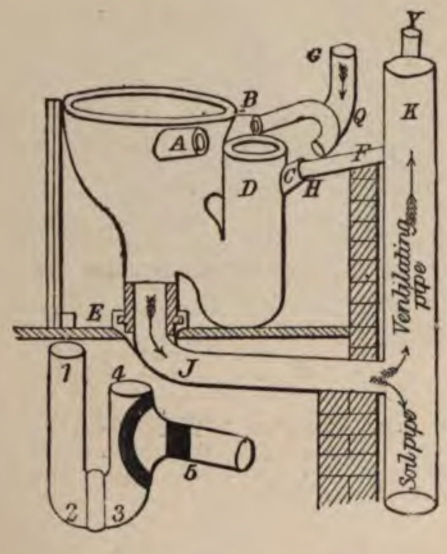


Fig. 576.

Cleansing Closet Basins.

Sometimes you will be required to clean out a closet basin; the best way to do this is to thoroughly wash it; then make a mop, which is done by tying a piece of rag round the end of a short stick, say 6in. long and ¾in. thick; then get a pound or so of spirits of salts, and with it and the mop wash the basin until the matter on the basin is thoroughly softened; then wash the basin, which should be as clean as a dinner plate.

The same applies to urinals, urinal waste pipes, &c.

Closet Safe Traps, and Flushing them with Weeping-Pipes.

It not uncommonly occurs that closets have to be fixed in the centre of a large building, on a staircase, or in some out-of-the-way place, and generally where it is almost impossible to take an overflow-pipe from the closet safe, and it would be a great deal too expensive to run one down by the side of the soil-pipe—in fact, it would be picking the proprietor's pocket.

Under such circumstances the difficulty may be overcome in the following manner:—Fix an additional small 6in. D-trap, as at E, Fig. 577, which, of course, is for taking away any overflow that might take place owing to the closet or pipe being out of order. For a plan of such traps refer to E, Fig. 456.

When these small traps are fixed, whether D, S, or P, it is imperative that they should be properly supplied with water every time the closet is used, and that they are securely protected against siphonage.

But to proceed with the flushing of the small safe trap, we must again examine Fig. 577. B is a piece of ½in. lead pipe, the end, J, being worked to a taper point, having a full ⅛in. hole bored into the point, as shown. Let this hole be the largest at the outside edge, and branched into the

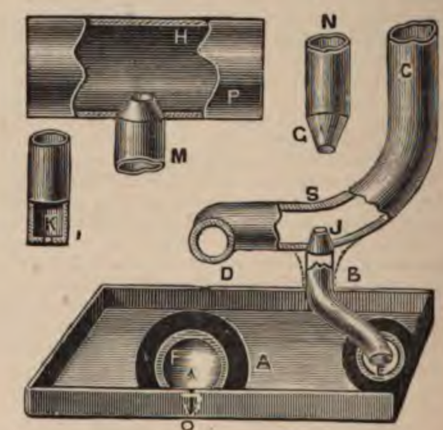


Fig. 577

1in. or 1¼in. closet supply pipe, as shown (this may come off regulator or other supply-pipes). Care should be taken to let the end of this pipe stand up inside the larger one about ¼in. or ⅜in.; thus the water thoroughly scours the end of this pipe, which, together with the hole being tapered from the outside, prevents any foreign substance getting or lodging in this small hole of the weeping-pipe. M H P is an enlarged view of this pipe. K illustrates the end of a weeping-pipe having the outer end closed, excepting the bradawl hole at K. Such a method is exceedingly dangerous, as the least bit of dirt, &c., is likely to block or wedge up the hole, and so prevent the passage of the water to supply the trap. N illustrates the end of the weeping-pipe as it is generally left by an unskilled plumber, which is as bad, or worse, than that shown at K.

CLOSET SERVICE BOXES AND VALVES.

Introduction.

Plumbers cannot give too much attention to the thorough flushing of closets, for upon this point, to a very great extent, depends the health of the poorer class homes. It so happens, more by Providence than anything else, that these homes are not pestered with the too complicated apparatus in the water-closet; but, on the contrary, are of the very simplest kind, for the reason that they are the cheapest that can be obtained, and good rough ones often work much the best; but even these closets require, and must have, the proper flushing, more so than a valve closet, because the latter may have only a dribble into the basin, and then it will work; but not so with the cottage closet, which *must* be complete in all points—viz., a thorough supply and proper sized pipes, valve, &c., when all will go well without attention for years, excepting proper treatment, no matter to what extent it may be used.

It often happens that in fitting up a closet and valves, whether it be of the waste-preventer kind or otherwise, little or no care is taken to select apparatus which are suited to each other, and which will work well together when fixed. Often a waste preventer giving a fair flush is fixed to an inferior closet basin, so that the benefit of the rapid flush of the waste preventer is lost in the basin, and *vice versa*, the result in either case being far from satisfactory.

The point that should be always kept in view is, to get as much flushing effect as possible out of the given quantity of water discharged at each use of the flushing cistern, so that the soil may be removed from the closet, and also carried along the drain.

I have for many years past made this branch of our trade my particular study. I have also taken out many patents for this purpose, some of which I shall place before you, though I shall not say which are my inventions, as this is not a trade catalogue. I shall also lay before you all those worthy of your attention, such as Jennings', Tylor's, Lambert's, Boulding's, Guest & Chrimes', &c., so that you may judge and be able to select those most suitable for your particular job, for there are many which will suit one job and be totally unfit for another. The old shoe, spring and round valve, and service-box arrangements have always been great favourites, because they will stand longer than any other valve, and for certain work will answer by far the best; but even these arrangements have been wonderfully improved by the introduction of a second box and siphon, or at other times by simply fixing the round valve over the mouth of the down pipe, and converting the air-pipe into a siphon, by which means it is impossible to get a less given quantity at each pull of the handle, a desideratum which should be enforced in every W.C. I shall commence this closet service-box work by describing the method of making the ordinary lead service-box, and then lead you step by step to the many different kinds to be found in the market, both in England and abroad. After this batch I shall give the different valves for fixing under the closet seat.

Lead Service Boxes and Water-Waste Preventers.

Fig. 578 shows the service box as made by the old school of plumbers. It is the best shape extant and the working thereof perfect, if not placed too far from W.C. Any valve for cistern work may be soldered on to this box, waste preventing or otherwise. A, Fig. 578, is the ordinary round valve, Fig. 582, soldered on the top of the box; this valve should be made with a water-way of not less than 2in., and have at least three to four cheese-head screws for taking the valve seating off the ring; the weight A is lead turned

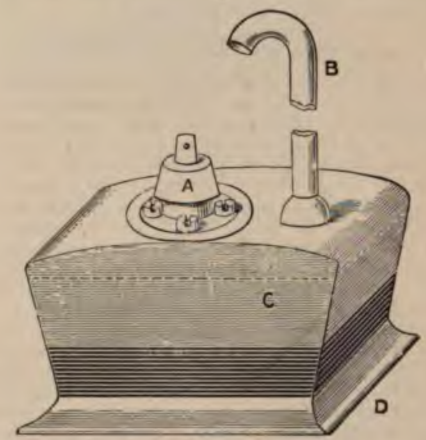


Fig. 578

up to a nice finish. B is the air pipe, the size of which should not be less than the down pipe C, Fig. 597. The air pipe requires explanation, for half our service boxes are spoiled in action by reason of the air pipe being made too small, generally ½in. or ¾in. is used. Say the outlet pipe C, Fig. 597, to be 1in. to 1¼in.; the valve suddenly opened, the box filled together with the air pipe, then suddenly let

Fig. 579.

the valve close, the drag of water to get air through a smaller pipe will be considerable, because this air pipe is at the moment of action, charged with water, thus effectually pre-

venting any air passing until the water is out. Now suppose the down pipe to be 1¼in. and the air pipe only ¾in., the water in the air pipe, in order to let the water out of the down pipe, must as it were fly out of the air pipe, otherwise there will be a drag or pressure exerted upon the outside of the service box (the inertia of the water in a smaller pipe is considerably greater), and that causes the top to sag inwardly, thus causing the valve to become lop-sided, or out of the upright, when leakage follows. This I have discovered by practice, but was many years before I could discover the real cause of bent-top service boxes. By working to this rule the unpleasant sucking noise so often heard in service-box pipes is prevented.

Cutting Out Service Boxes.

Fig. 579 is the method of cutting out service boxes. The drawing is to 1½in. scale, and needs very little description. First, take a piece of lead and square it to the required size, namely 16in. by 13in.; then from the corners, A, B, C, D, set back the dotted lines, E E, G G, F F, H H, 4in., which will give the size of box top, 8in. by 5in.; then if your solder round bottom is to be 1in. wide each side, set back the angle lines, 1, 2, 3, 4, 5, 6, 7, 8, 1in., or better 1¼in., from E to J, also from G to J, also from F to J, also from H to J; then rasp these edges, 1, 2, 3, 4, 5, 6, 7, 8, to an angle for forming a mitre. Soil the inside all over within ¾in. of angles, then shave same as shown at 6, 9, 8; next bend up the sides (a chase wedge is handy here) of the box to the shape of Fig. 578, and with a piece of string or strap tie it up ready for soldering. You can place the box on the corner edge to solder, but be sure and have the corners properly closed first. Next square up the bottom so that it will rest truly flat on the bottom, next soil and shave all round the bottom edge, say 2½in. the soiling, and ¾in. the shaving; make a bradawl hole in the top for vent, and solder bottom on. The reason why the box is made tapering is to allow the bottom to pass through the hole in the cistern without letting the top fall through, and for this reason you must not forget to have the top larger than the bottom. If it is not large enough you must, after soldering on the bottom, trim it off accordingly. Some lead workers soil all round the outside of each angle ½in., as in making Ɔ-traps. N.B. Use the solder for the angles as coarse as possible to prevent melting when fixing the box. Sometimes the box is bossed up to the shape shown at A E D, Fig. 580, to drop through the bottom of the cistern; a flange turned as at E; the down pipe soldered into the bottom; after which the top is wiped on with the turned flange to the bottom of the cistern. This makes a first-rate job.

Round Service Boxes.

Fig. 580 is a round box, and is made for strength. It is first cut out of a round piece of lead according to the desired size. About 15in. over will make a fair sized box.

FIG. 580.

Then take the mallet and dresser and work the sides A A up as follows:—First lay the lead on a soft piece of wood hollowed out like the bottom of a bowl. Then with the blunt end of the mallet make the sides of the lead to this shape by beating it from the inside. This must be done without cripples or puckers; by going slowly and cautiously to work, and by working all round the edges first, you will find no difficulty. Having worked up the edges as much as possible, take the dummy and dresser, and by placing the dummy inside work the outside over the way you would have it go until it is to the shape required. Then cut out the bottom and solder it on (having first made an air hole in the top of the box). If the box is to be let down into the cistern, as the square one, N E, Fig. 598, J, Fig. 566, B, Fig. 597, let the bottom be 1½in. smaller than the top. The valve is soldered on the top point of this box. Sometimes this box is made by soldering on the top and bottom. This box is also made for slate or iron cisterns, when the bottom of the same is first fixed with a boiler screw and the body soldered on after. The boiler screw should be well screwed up first, and not pass too far through, unless you wish the boiler screw to form a weeping pipe as that at Fig. 581. It will at once be seen that the service box is the best shape for standing the thrust of the water from the cistern, by reason of its shape. If you wish to screw this box to an iron cistern after it is made, you can do so through the valve ring by having a spanner made like a fork, which must fit the nut tightly. Remember to fix the valve over the hole in the bottom. Sometimes the box is fixed with a brass flange and screws made to pass through the bottom of the cistern.

Weeping After-flush Service Box.

Fig. 581 is a weeping-service box, introduced where some kinds of waste preventers are used, for slowly supplying

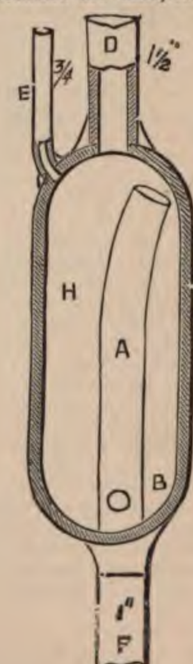


FIG 581.

the necessary quantity of water to charge the pan or basin after the main valve is closed or the ordinary service box emptied. It is generally made with a short piece of 4in.

soil pipe, worked over at the two ends with the bossing-stick, or dresser and dummy, the outlet pipe A being pushed through the bottom and soldered. This pipe should be bent over against the side as shown at top, and should have a one-quarter inch hole within one inch of the bottom of the chamber, as at B. This pipe is the real advantage of such apparatus. Suppose the inlet D to be charged with water, the air pipe E, which should be of the same size as that of the down pipe, and not ⅜in. as shown, will take the air out of the chamber, and of course the chamber is filled with water, and charges the pipe A, which flushes the closets, &c. Stop the water running through the pipe D, and the water ceases to overflow the pipe A, but will trickle away down the pipe F, through the aperture B, until the chamber H is exhausted.

This form of weeping-box is made to stand behind casings, &c. A square box will work just as well with the down-pipe standing up in the box. See N, Fig. 598, Fig. 663, and Fig. 664, A, Fig. 626, &c.

VALVES FOR CLOSET WORK.

The Round Valve.

Fig. 582 is the well-known round valve, as fixed at A, Fig. 578, A, Fig. 590, J, Fig. 598, &c. They are made with or without the cheese-headed screws; sometimes to screw on with a washer like cock bosses, &c., but this is not at all a good plan, as it is troublesome to unscrew them after standing for a long time, and requires a large screw wrench, which perhaps is not always at hand. This valve

Fig. 582

is easily repaired at any time, with a new washer, by unscrewing. It is apt to get lop-sided, by reason of an insufficient sized air pipe being fixed; they are then likely to leak, because the leather does not fit the seating. If the box is made too light it gets lop-sided.

Spring Valves.

Let us now examine Fig. 583 and see the advantages of these valves. A 2, Fig. 592, illustrates the valve fixed; it was invented by Bramah in the year 1778. E is the leather valve, which should work loose on the lever, and is made to close upward against the seating. This valve is worked by the rod L, which passes through the air-pipe, M, and is attached to the lever N, upon the spring-board. [See C, W, D, B, A, V, E, Fig. 571.] On this rod there is a sling at O; this is simply a long screw to adjust the length of the rod to suit the spring, P. The office of the spring P, Fig. 592, is to keep the valve E tight up to the seating. Now, having all complete with air-pipe and spring all adjusted, as shown, pull the wire which brings down the lever, N. This compresses the spring, and allows the rod to fall, thereby opening the valve. This of course, charges the box with water, which runs down

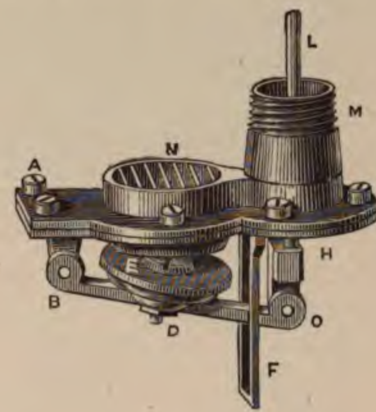


Fig. 583.

the pipe Q to closet. On letting go the wire the valve closes, and leaves the box full of water, which in its turn takes time to empty; this gives the flush of water after the handle is let go necessary to fill the closet pan or basin. This valve is known as the spring-valve, and is largely used for places where the frost is likely to interfere with the working of the wire, when in water, as in this case the wire or rod is only wet when the box is full of water. It is a splendid valve. On referring to the spring valve Fig. 583, it will be seen that this has a strainer formed on the inlet N. For repairing this valve, first disconnect the rod and sling off spring-board, Fig. 592, and the screws on box and re-leather. See that the spring is sufficiently strong, or fix a new one. In lieu of a spring I have used a weight and pulley, which works very well, but the spring is best.

The Shoe Valve.

This is illustrated at Fig. 584, and also as fixed on a service box in cistern at B 2, Fig 592. This works with a ball-lever, and is, I think, an improvement upon the spring

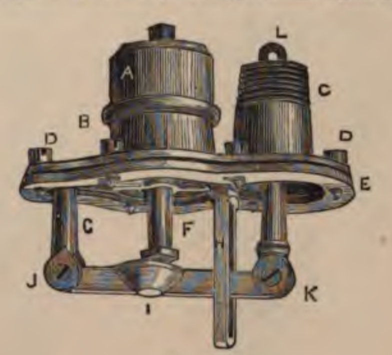


Fig. 584.

valve, inasmuch as it does not depend upon a spring for its closing action, but on gravitation. It has the same advantage of the wire being out of the water as the spring

valve. To repair this valve, take out the screws, D D, on top of box and re-leather valve. I may here remark that whatever valve is used, the same should always be fixed plumb under the ball lever, and not lop-sided. As before stated, any kind of cistern valve may be fixed upon these service boxes, if large enough. If a waste preventer is fixed, then the weeping pipe, K, may be used, but should not come up more than 3in. into the box; make the weeping hole about ½in. diameter.

The Spindle Valve.

Fig. 585 is the spindle valve. It is ground in—that is, metal to metal, without leather. A, the body; B, the valve; C, the spindle; which is provided with a nut. This nut should be soldered on before fixing the valve. *This is important*, as the nut is likely to work off in time. This valve will last well, if it is a good one, and if there

FIG. 585.

FIG. 586.

is an air-pipe fixed on the down pipe to prevent the valve slamming. This valve will stand hot water, and is useful for many different purposes. Sometimes the spindle is of double length, and then the valve is called a long spindle valve. This valve is shown fixed at B, Fig. 594, also at D, Fig. 598, &c.

Screwed Spindle Valve.

Fig. 586 is the above valve, with the screw, A, on the bottom for iron pipe.

Long Spindle Valve.

Fig. 587 is a long spindle valve for pump, closet, and other work. This valve is handy for places such as at


FIG. 587.

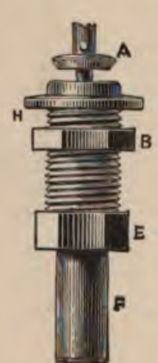


FIG. 588.

FIG. 589.

E and J, Fig. 598, and at B, Fig. 594, or other places where there is no chance of getting at the valve. It is also much used in the old leaden pumps, for which see my Pump Work.

Slate Cistern Spindle Valves.

Fig. 588 is a slate cistern spindle valve, with fly nut and union. This valve is made for slate or iron cisterns, and, as shown, is very useful for this purpose, as it can be fixed in a few minutes. A is the valve; B, the fly nut; E, the deep nut; F, the lining. The whole combined forms a slate cistern spindle valve, with fly nut and union. In fixing this, always fix it with a red lead grummet round the flange H, and do not screw it up too tight to cistern.

Fig. 589 is the same kind of valve as Fig. 588, but having a leather valve A, and an air-pipe B—which I think very little of, because nine-tenths of them are only ½in. brass tube stuck into the body of the valve. They are not so good as the ground-in valve, unless it is for places where the frost would spoil the latter.

The Cistern Valve Well (or Valve Well).

Fig. 590 is a valve well for lead cisterns. This well is fixed in order to fix the valve in such a position that all the useful effect of the cistern may be utilized. It should always be covered over with a grating of some kind, generally a perforated piece of sheet lead. By covering it watertight over, with weeping-hole and air pipe, with ground-in valve, it answers for Fig. 594 first-class, as you can better empty the cistern.

Pull the valve up and the water runs through and

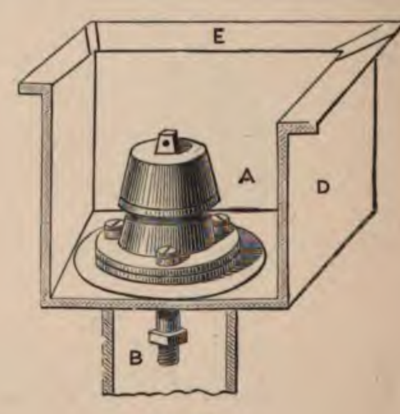


FIG. 590.

flushes the closet (but suppose this valve not to be within the box, but a cock or valve fixed on the pipe below, it will answer the same purpose). Shut the valve and the box refills. Keep the valve open, and only the limited quantity of water can pass through the hole into the box and through the valve.

Twin Service Boxes.

Fig. 591 is a plan of Fig. 593 at A B.—In large houses it is a common thing to have two or three service boxes fixed in one cistern, and generally all want to be in one place to suit the wires or pipes. It is then often best to make twin boxes, as shown at Figs. 592 and 593, which are made as follows: First, solder in your pipes in bottom

of cistern where required, say 6in. apart, then take a piece of sheet lead, say 6in. by 7in., to make the partition, and

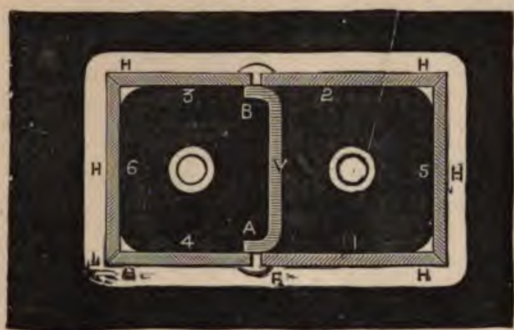


FIG. 591.

bend it to the shape, as at A B Fig. 591. This is for the sides of the box to stand up against; also bend over to the same angle or square the top, as at C, Fig. 592 · next soil

to stand. Next, prepare the boxes by making the two with only one end in each sectional plan, as shown at Fig. 591.

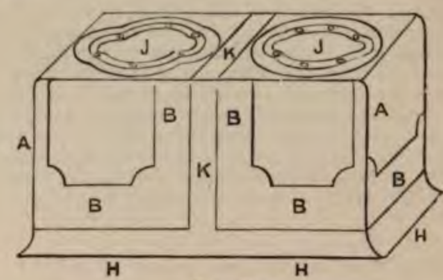


FIG. 593.

The sides are indicated by the plan and at 1, 2, 3, 4; they are mitred and soldered up as in an ordinary service-box, only square. Having done this, next soil and shave them round the bottoms and up the sides, and over the top

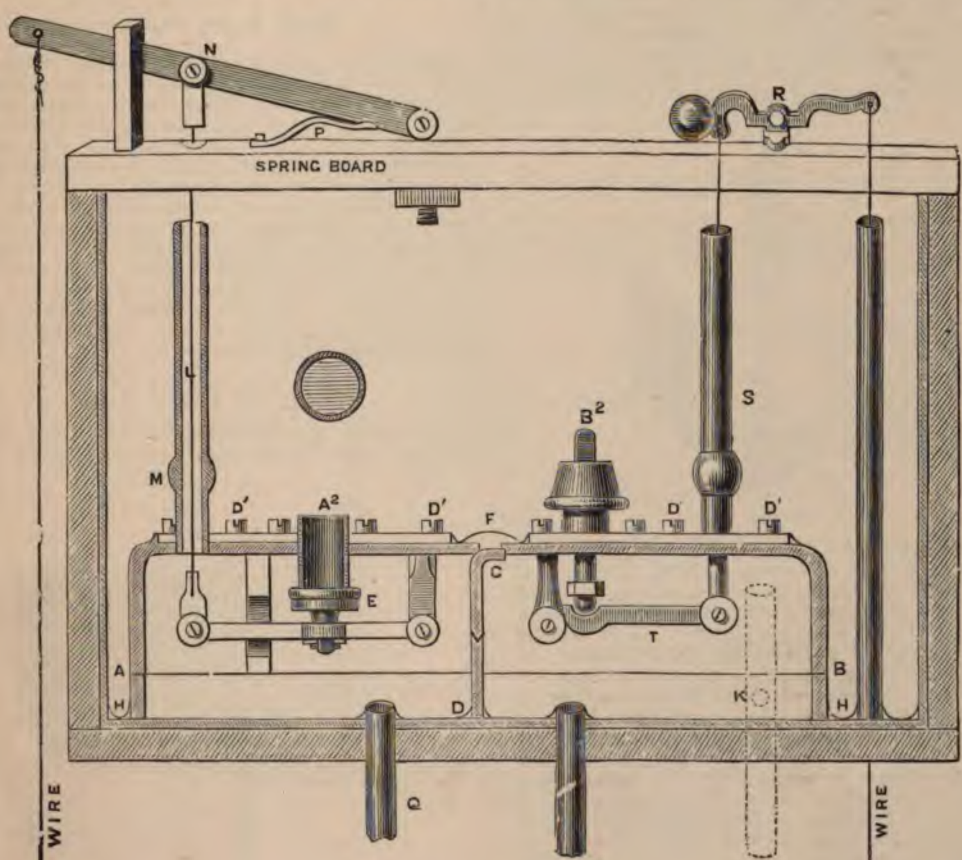


FIG. 592.

and shave all round these angles, top and side, also along the bottom, as at D, Fig. 592, and solder same to the bottom of cistern just where you may wish the centre of the box

of the box without end; also prepare the bottom of the cistern to receive them—that is, soil and shave. Put them over the prepared and fixed partition, and let the sides butt

within $\frac{1}{4}$in. or $\frac{3}{8}$in., as shown at F, Figs. 591 and 592; then solder all round the bottom of the boxes first, as at H H H H H H, Figs. 592 and 593. Having done this, take some pasted paper, and then fix the paper on that part of the solder which may be in the way when soldering round the upright part or side and over the top of prepared work. This will keep the bottom solder clean and free from splashes. Then solder same, first wipe the top half-way and down one side, finish neatly; then return to the top and warm up the solder and finish from top and down side and leave the work as shown at K K, Fig. 593; you can either fix the brass valve washers, J J, Fig. 593, before the soldering down of the boxes or afterwards; before is best in some cases.

The Box Waste Preventer. (Fig. 594.)

This is a form of waste preventer. It is the simplest that I know of, and is, as will be seen, not a positive water waste preventer, but partial, inasmuch as it allows the water always to run to a limited extent when the closet valve is open. It is simply a square or other shaped box, having the inlet or weeping hole, A, and which is the only inlet into box. This hole should be made according to circumstances, from $\frac{1}{4}$in. upwards. The air-pipe D answers two purposes, it is used as an air-pipe or as an opening for the wire C to work through. This wire is, of course, to work the spindle valve B, and is in the ordinary way connected with the ball-lever.

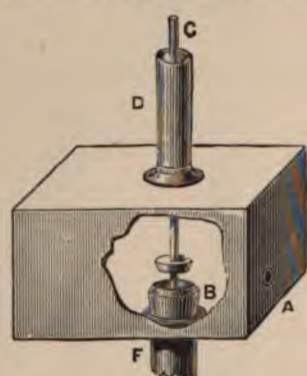


FIG. 594.

This box will answer for other pipes, as will be hereafter written upon. F is the down pipe to W.C. The mode of fixing this box is,—first, to fix the down pipe to the bottom of the cistern, *with or without valve B*. Remember this valve should be a first-class *ground-in* spindle valve, if used, as there is no chance of re-leathering without cutting the box or by having a large cap and screw to get at it. Next, take the box and air-pipe complete, and put the wire through the air-pipe and solder same over valve to bottom of cistern, and if an iron or slate cistern, screw the lot down together—that is, the bottom of box and the valve; after which solder the box thereto; remember to fix some brown paper under the lead to keep the heat from the iron or slate. The action of this box is as follows: Having the lot submerged in the bottom of the cistern, the box must fill through the hole A. Say this takes one minute. Then pull the valve up and the water runs through and flushes the closet. (But suppose this valve not to be within the box, but a cock or valve fixed on a pipe below it will answer the same purpose.) Shut the valve and the box refills. Keep the valve open, and only the limited quantity of water can pass through the hole into the box and through the valve. Fig. 595 illustrates the box waste preventer made round, and having a top to screw on to take out the valve; the air hole and inlet hole at bottom are clearly shown

FIG. 595.

The engraving Fig. 597 is the service box fixed with valve and air pipe complete, showing it for a pan or valve W.C. in a lead cistern, A the valve, B the service box, which should be kept as low as possible in cistern D.

Water Waste Preventers.

Some water companies enforce the use of waste preventers, and according to the locality, so you will find the different varieties used. For this reason it would be necessary for me to illustrate and explain them at considerable length, for should I only give a description of one or two, this work would simply be useful to those who may have to fix these particular waste preventers. But for a commencement I will introduce to your notice the celebrated frugal valve, as fixed at Fig. 597, which may be summed up as that of a simple boy's sucker applied to the flat top of a round valve, which, when the wire is pulled, sucks up the valve, holds it for a minute or so, and allows it to drop off and so close the valve seating, of which more will be said when illustrating the frugal valve in section. Sometimes this frugal valve is known as the Triton valve.

Fixing the Frugal Valve.

The diagram Fig. 596 illustrates the method of fixing the frugal valve over the mouth of a down pipe for supply-

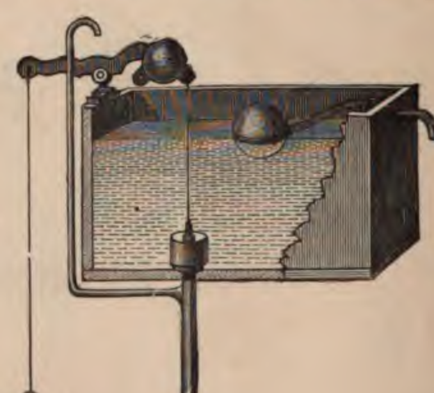


FIG. 596.

ing a hopper closet. When fixing this, be sure to fix the air pipe and carry it well above the top of the cistern.

Frugal Valve over a Service Box.

This is illustrated at Fig. 597, and is nothing more than

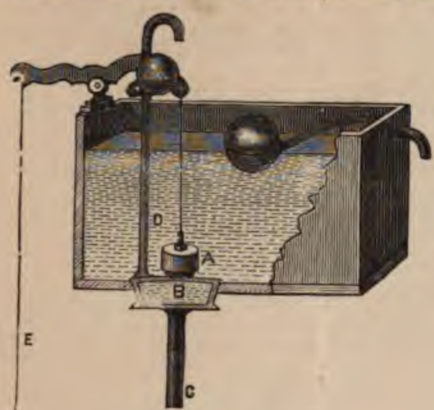


FIG. 597.

fixing a round valve, as at A, Fig. 578, over the service box for giving the after flush to valve closets, etc.

Double Valve Waste-preventing Service Box for Lead Cisterns.

Now, suppose that you have a good lead cistern, with service box and valve complete and in good working order, but owing to some cause or other there is too much water used, and that an effort must be made some way or other to prevent waste. (The first attempt of this kind, I may mention, is due to the ancient monks, for we read that they stinted out their holy water with a kind of waste-preventer, the title of which was the *Lustral Vase.* I have made one exactly like those of the Middle Ages, and obtained a perfect water waste preventer.) Now, as it would be a pity to disturb the old cistern service box, etc., make a new box, A, Fig. 598, to cover the old box, the new box to have a piece of pipe, B, with a small spindle valve, D, branched into it as shown. First, take off the round valve and re-leather same (or, better still, get a piece of pure india-rubber, which will last twenty years for this purpose), then take off the bottom or spindle nut E, and fix the valve without. Then put the new box over the old box and solder down same to cistern, and make good the air-pipe round top. After this, have some good new $\frac{1}{8}$in. copper wire (closet wire) and with proper links, formed as at F, thread the piece of 3in. or 4in. pipe and solder same to box; also wire the inlet valve D, as shown, to the ball-lever, taking care that the mode of wiring is such as shown—that is, for the inlet valve to be always closed when the outlet is open, and *vice versâ.*

N.B.—By reversing the lever, this makes a first class seat-action closet valve, that is by fixing the ball H to work the inlet action valve D. This is my first attempt at making seat-action closets. Of course *one box* will do for this purpose, the top or new one; the valve J is then fixed over the down pipe L, and no air-pipe K needed. If you like, by the introduction of the pipe N through the box, this forms the weeping service box.

Waste Preventer Cistern and Closet Fixed.

Before I proceed further with waste preventers, I will show one as fixed to a balloon basin, complete. This may be seen at Fig. 599. The waste preventer cistern should be fixed at least six or eight feet above the closet, and should have a $1\frac{1}{4}$in., or at least $1\frac{1}{4}$in., lead pipe with easy bend.

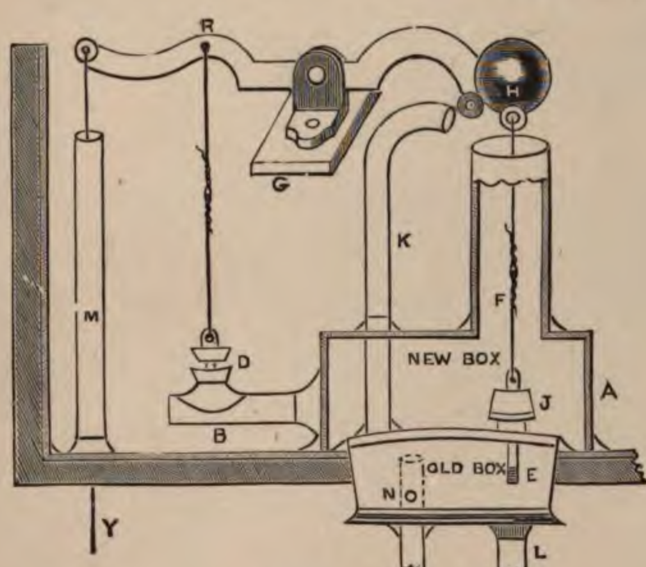


FIG. 598.

and fitted to the arm of the closet basin when all is complete. [For iron brackets for supporting the cistern, see Figs. 659 and 660.]

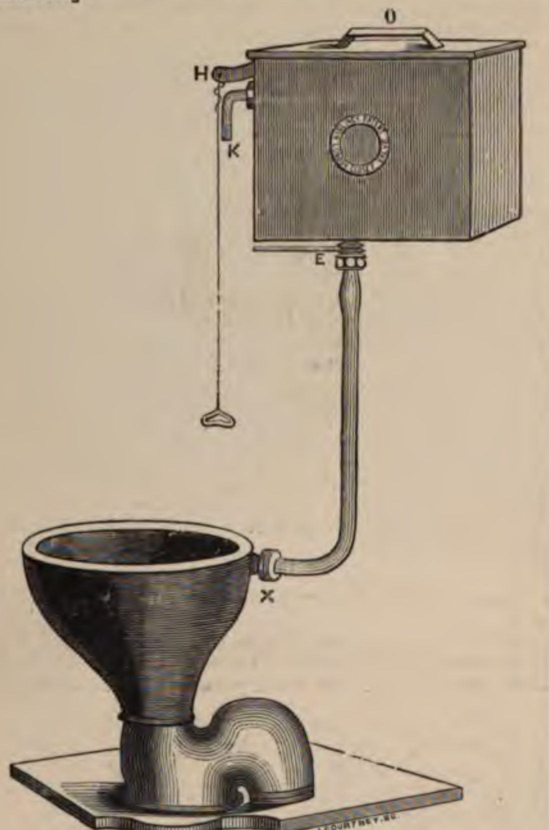


FIG. 599.

Service Boxes.

J. Stone & Co's. water waste preventing service box. This is a very effective, cheap and useful service box, with valve and air-pipe together with union and flynut complete. They have been largely used by the Surrey side of the river plumbers. Fig. 600 is the valve and box complete, with cam, ball, lever and chain. This waste preventer is a very strong make. I need scarcely say that by pulling up the rod or air-pipe (to which the chain is attached) that it first closes the inlet valve, and by continuing the pull it next opens the half-round valve (which is of rubber), and allows only the contents of the box to flush the closet. To repair this, unscrew the guide on top, take out the diaphragm and valve, and re-rubber same.

Wallis & Connel's Box Valve.

This service box valve [Fig. 601], is used in Glasgow; it, as can be seen, is a cylinder C, having a hollow piston D, the lower end of which passes through the collar F, and

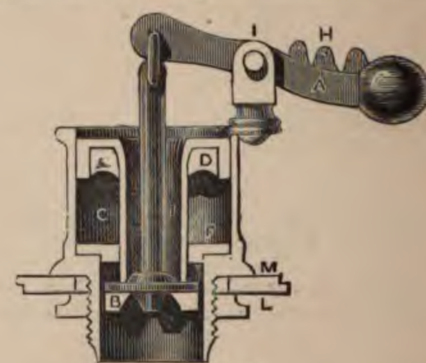


FIG. 601.

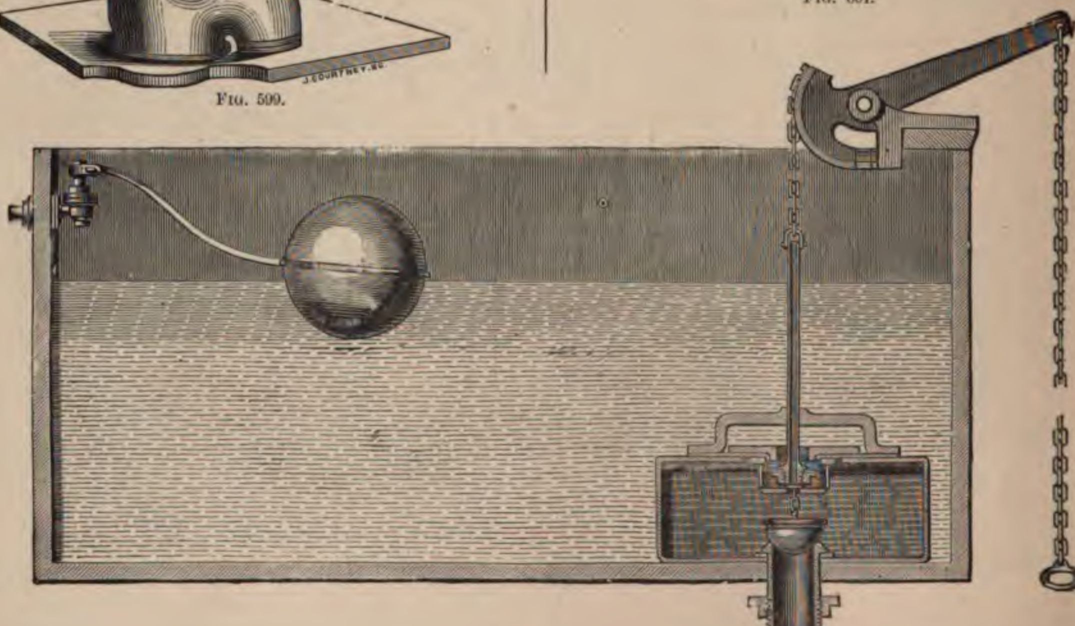


FIG. 600.

forms a valve seating which bears on the rubber face B. The action is as follows: On raising the lever at A, the valve face B is lowered, then the piston slowly follows, pressing the water from the cylinder F C, through the slack part of the piston D. Suppose it to follow the valve, and the piston seating to sit upon same, the waterway will be stopped up, and no more can be obtained until the valve is again brought up by reason of A being allowed to fall. Then pull up again and open the waterway, and a fresh supply will be obtained. This valve has been made in many different forms both to work below the closet seat and for fixing in cisterns.

London Closet Valve, Patent 1,579 of 1873.

This waste preventer was largely used about the years 1872 to 1876, and will be readily understood from the following:—Fig. 602 is a large round box, having a valve seating at E D, F is the hole for the air pipe, C is a hollow spindle, working through a cup leather or stuffing box at C. On the bottom of this hollow spindle is formed a valve of peculiar construction; it is like a cup and ball joint for a gas chandelier, the ball part of which at A forms a valve against the seating B, and will be understood as follows:—Suppose the apparatus fixed in a cistern below water, and all full, on pulling up the hollow spindle, this first closes the inlet valve A B to the box; now continue the pulling of the hollow spindle, this lifts the valve D, and the water within the box runs down through the seating to the closet; now let fall the spindle and the valve D closes; then the hollow spindle drops, as from B to A, and the water runs down the hollow spindle through the valve box A B, and re-charges the large box. The valve can be taken out of the box by unscrewing the top.

Fig. 603 illustrates the London closet valve, as just explained, fixed in a body or cylinder, A I, B and C, for fixing, as shown, at Fig. 604, and will be understood by the following description:—First, you saw that the spindle C, Fig. 602, was hollow, and that it worked through a cup leather, that it had a cup and ball valve at the bottom; then Fig. 604 is just the same, but instead of being fixed on

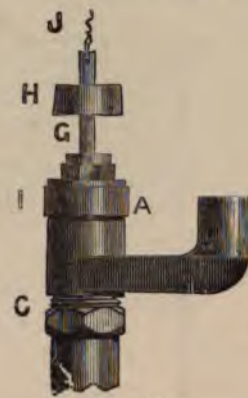


Fig. 603.

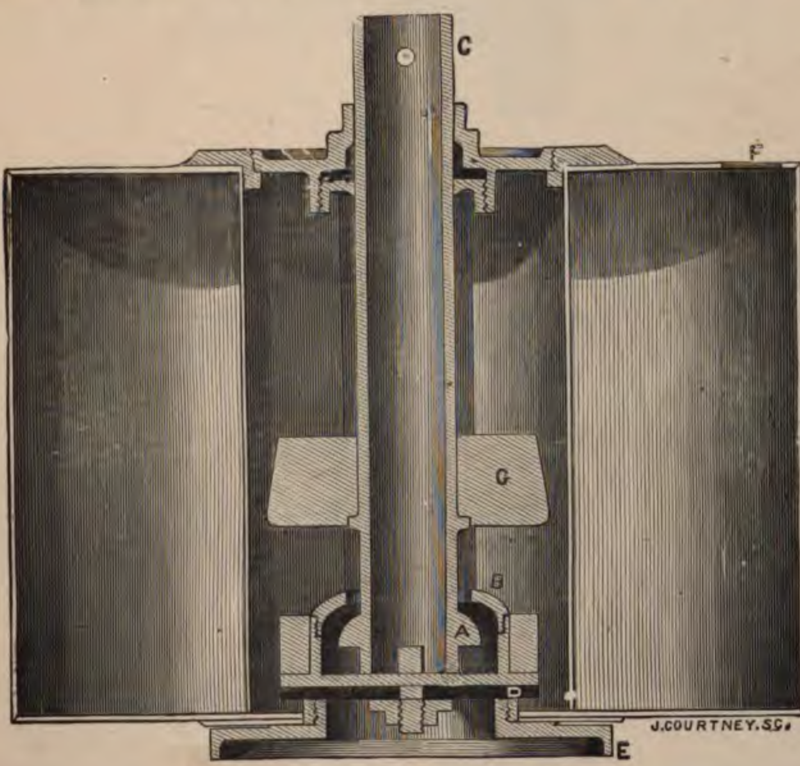


Fig. 602.

the top of the box and through same, it is fixed lower down (see the section at B D Q, Fig. 610); the water runs through the hollow spindle at C, Fig. 604, down and up again at B, and so charges the box E; but on pulling up the spindle C, it, as in Fig. 602, first closes the inlet to box, and by continuing the pull it opens the bottom valve, when the water from the box runs out again by and through the tube B, and to the down pipe. Fig. 605 is the same valve

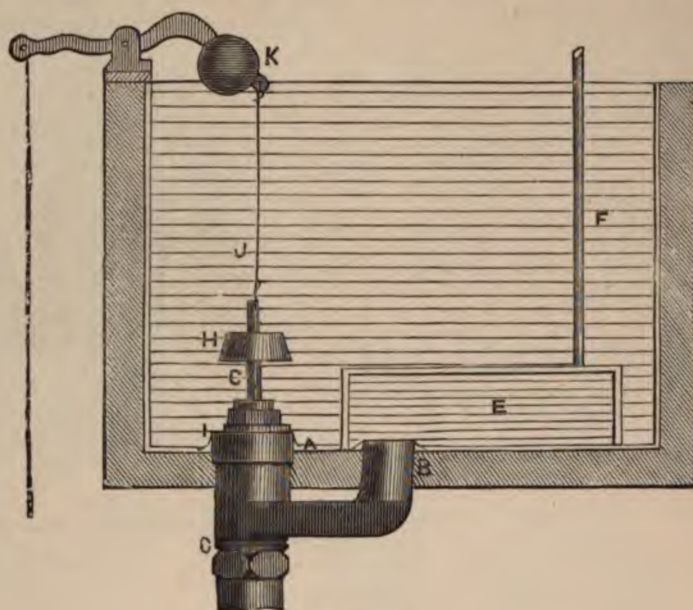


FIG. 604.

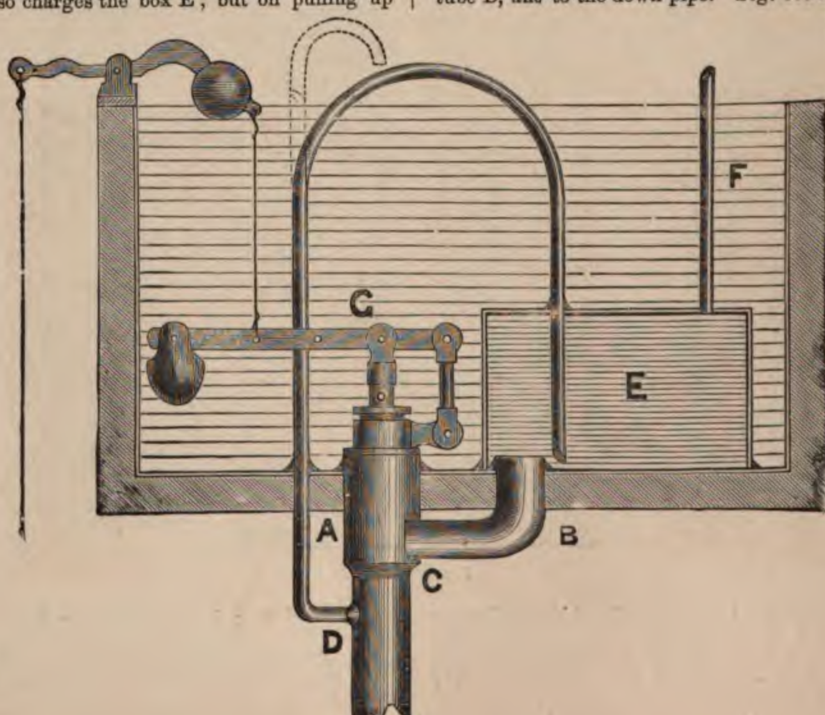


FIG. 605.

but worked differently, the difference being that this valve is worked with a lever submerged as shown; the advantage is that the lever has more power for the size of weight upon the spindle, which, in order to make a perfect joint round same, should be packed; it also allows the ball lever more play. It also illustrates the air pipe D A converted into a siphon. This air pipe should be of the same size as the down pipe C.

Fig. 606 illustrates the same valve, but made to screw down on a flange C, which is soldered over the mouth of a down pipe; the box is filled through the holes in the spindle at G; F is the place for the air pipe.

Fig. 607. This is another of these service boxes, working with the cup and ball valve, but having retarding mechanism to prevent the valve closing too quick; and a kind of after flush arrangement, not much used on account of the oxidation; you will see, on pulling up the hollow spindle, that it also brings up the weight G;

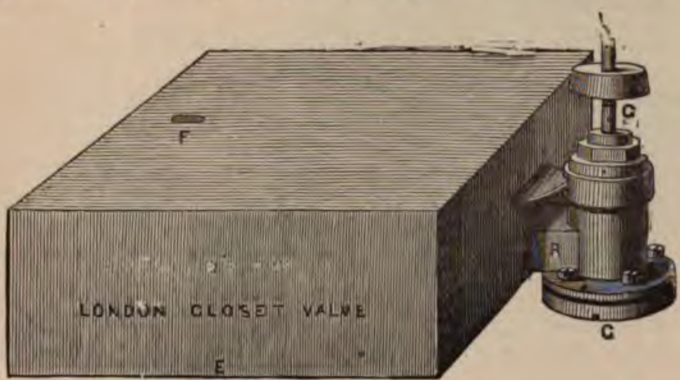


FIG. 606.

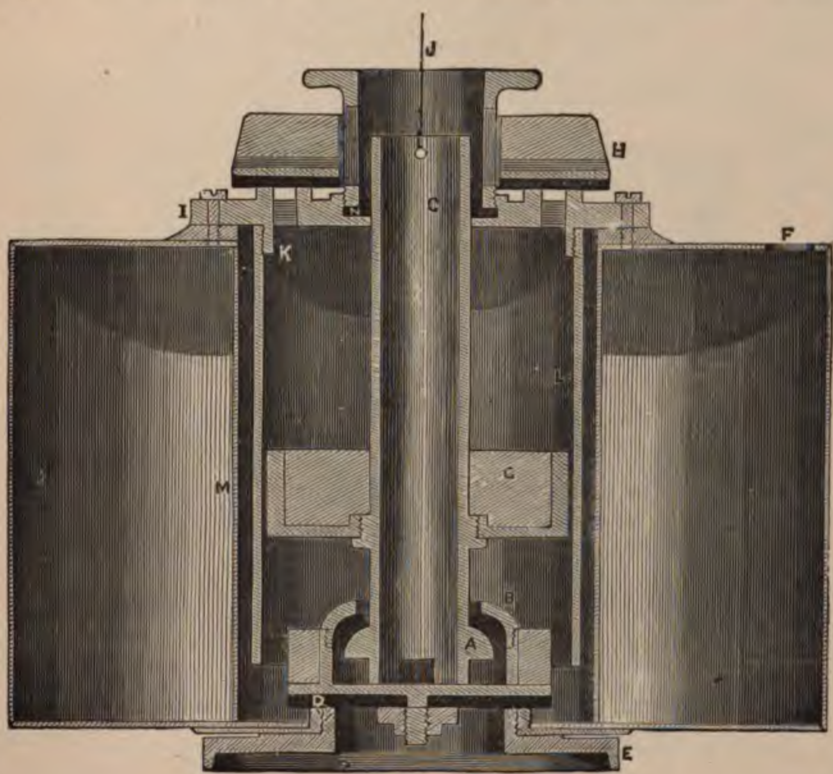


FIG. 607.

this is a fairly fitting plunger or piston within the brass cylinder L; by pulling it up it opens the relief valve H, and allows the water to pass out, but by releasing the spindle the plunger comes into play, and is kept from dropping quickly by reason of the retarding valve closing the top part of the cylinder; the water space between the top of cylinder and plunger is filled by the water passing be-

FIG. 608.

tween the inside of the cylinder and the outside of the plunger, when the plunger is allowed to slowly fall, carrying the outlet valve with it, thereby closing the seating D. The way to repair this valve is by taking out the cheese-headed screws in the top. This box is made of lead, copper or zinc.

Fig. 608 is an elevation of Fig. 602, which requires no further description.

Waste Preventing Cisterns.

Fig. 609. This is made of lead, copper, and zinc, and works very well; but as there is not one plumber out of ten who can repair the same, it may be useful to explain how to do it. First, take off the wire at J, and you will then be able to put a key-spanner over the top. Unscrew the top, and take the valve out, when it can be easily re-leathered. Sometimes you will find this service box valve screwed together with small cheese-headed screws, which is much the best plan. The action of this service box cistern is as follows:—Suppose the lower part, N, of the box to be full of water, and also the upper part, which is parted off by the partition, M, the water could not run out of the lower part of the box without vent; then to get vent there is a siphon formed up the one angle at P and L, the outside plate which forms this siphon. Now pull up the valve, and the water from the lower part will try to pass the outlet valve, but before this takes place some more water must take its place, when the weight of the water from below draws that from above, so that the top part of this box is really emptied first. But as the box would not be an effectual preventer if this was not stopped in some way or other (because by keeping the outlet valve partially open just equally to the income from main pipe,

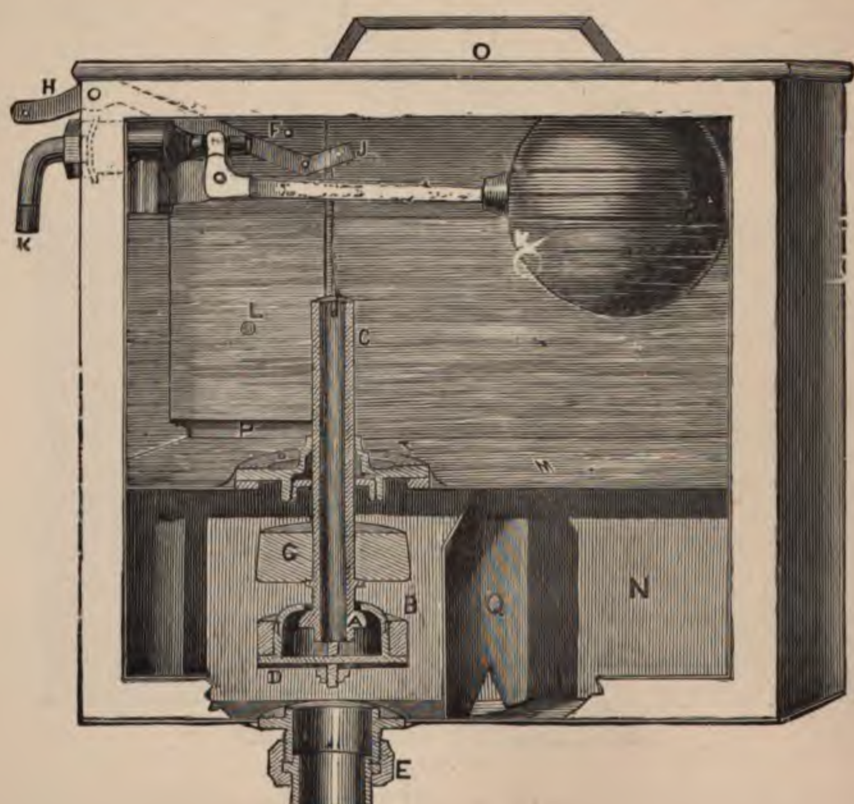


FIG. 609.

the valve would always leak), which is effectually done with the small air-hole, F, which should be within 1in. of the highest point of the water level. Now by having the hole here, pull up the valve slowly, or a very little, and this air-hole will give sufficient air in the siphon to allow the bottom box, N, to empty; but pull the valve open in the ordinary way, and the whole of the water out of the top and bottom of the cistern will be discharged. If you do not require all to be taken out of the top part, make a larger hole in the siphon where you would like the water to stand, as at L, and this will let in sufficient air to break the siphon action, that is as soon as the water gets below this point.

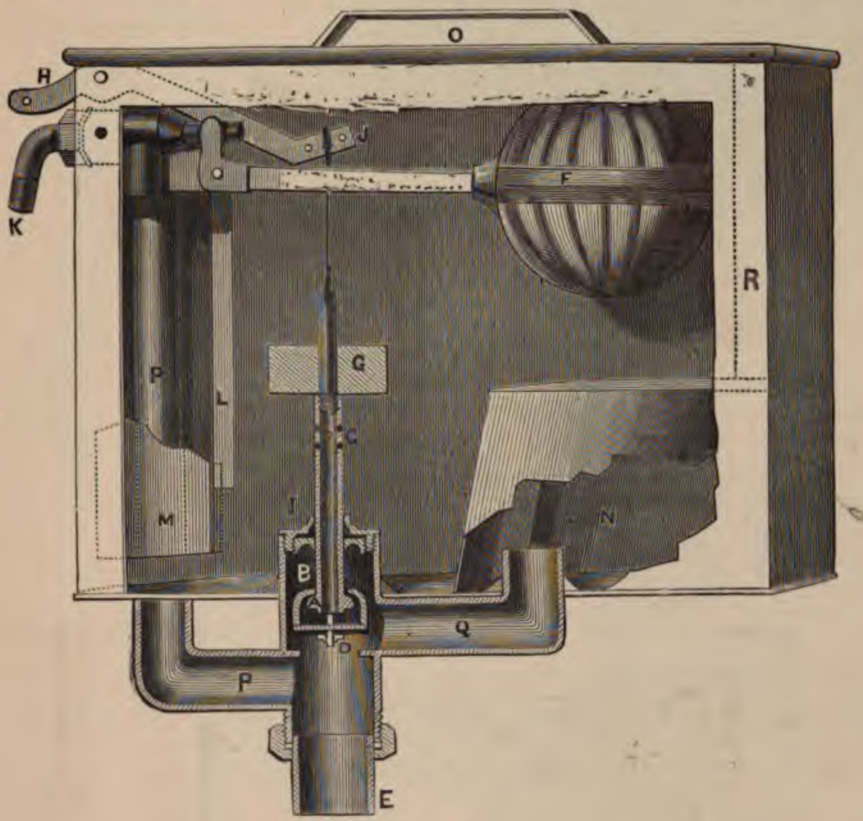


Fig. 610.

Double Action Waste Preventing Cistern.

Fig. 610. This cistern is something like the last described, but this is designed to give neither a greater nor a less quantity than the two gallons (a most important invention). This cistern is useful for all kinds of places, no matter where, as the person using it cannot get less than a given quantity. The action is as follows:—N is the service box, as in Figs. 602 and 604. Suppose this to be full of water; pull the hollow spindle G, which first closes the cup-and-ball valve A. By continuing the pull the outlet valve D opens, and a clear passage is left between N and the down pipe through Q. R is the air-pipe. Now close the valve D before the two gallons are run out of N, and the drag of water in the down pipe brings the siphon P into play. The siphon is formed inside the angle of the service-box, as in Fig. 609, the bottom of which is at M. L is a tube answering the purpose of L, Fig. 609.

In the above invention it will be observed, that, should the handle be held up until the box N is emptied, that on letting go the pull, the siphon P cannot be started, inasmuch as air will be admitted into the down pipe E, which will of course prevent the sucking action necessary for producing the after-flush through the siphon M; therefore this waste preventer will require particular attention if the after-flush action is required. To get over this difficulty, the top of the chamber N should be open to the top of the cistern, which will give more force to the water within the down pipe; this being so, a portion of the water will run up the siphon pipe P to about M, and on its return will effectually start the siphon, and so give the after-flush at each operation. There can be no mistake about the efficiency of this cistern as a perfect water waste preventer, but for some reason (its cost, I believe) it is not much used. I have seen one which has been in constant use on the New River Water Works pipes ever since the year 1873, and has worked well without attention ever since.

I will now give you the method of fitting these valves in cisterns under water, and which is illustrated in the following diagram.

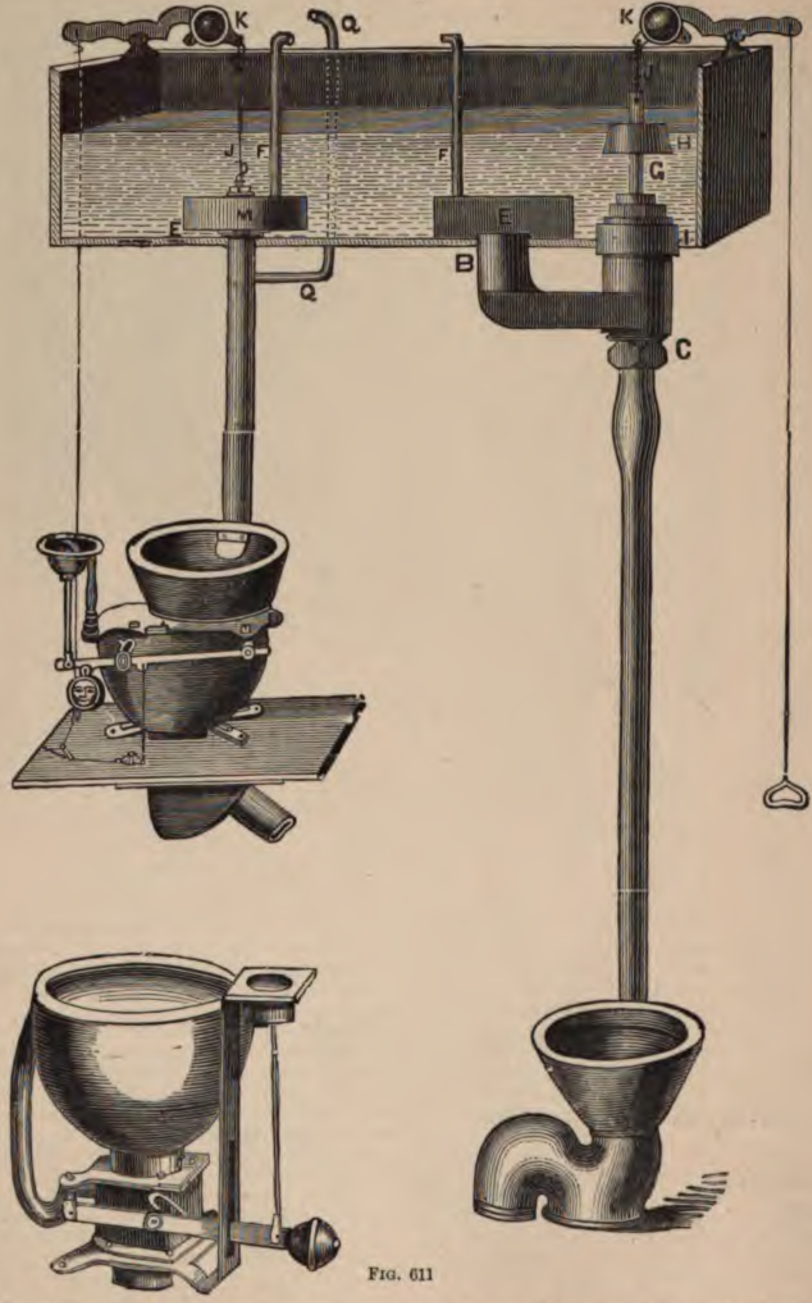


FIG. 611

Cistern Waste Preventer Arrangement.

This is illustrated at Fig. 611; it shows the valve Fig. 607 fixed in the cistern, as at M, for supplying a pan or valve closet; it also shows the wiring of the cranks and ball lever; and also the air pipe F Q, which should have been drawn to the size of the down pipe. This diagram also illustrates the method of fixing a waste preventer for supplying common closets with pull and ball lever arrangements.

Single Diaphragm Waste-Preventing Valves (Patent No. 1179, of A.D. 1876).

Fig. 612 represents one of the first single diaphragm waste-preventing valves. They have been made to a very great extent, on account of their extreme simplicity.

They are suitable for a servants' closet, or may be fixed over a service box for either valve or pan-closets. G is

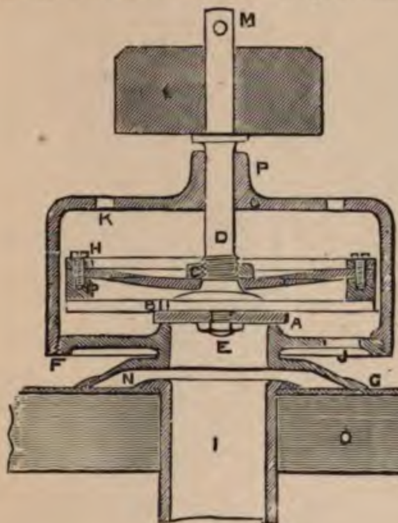


FIG. 612.

the seating to be soldered to the bottom of the cistern, and over the down-pipe I, or this may be connected by nut and screw to the cistern. M is the pull-up spindle for attaching the copper wire, D (which may be made to work through a stuffing box at P), the spindle for actuating the flexible diaphragm C. This diaphragm is fixed at H to the ring P, which is also connected to the valve-plate B. At B is a small regulating hole, for the purpose of allowing the descent of the valve when the spindle is being held up. The action is, that on pulling up the spindle D, it brings up the flexible diaphragm, and, with it, the outlet valve A; but as the top Q limits the amount of lift to both diaphragm and valve, the flexibility of the diaphragm, and a small water passage being established at B into the space between the diaphragm and the bottom plate, it allows the valve to descend slowly, and so cuts off the water from above and below the valve-seating. This valve has been made to work under the closet seat, and is done by making the casing Q watertight with a stuffing-box, and by cutting a thread either at J or any other part of the valve-casing. Of course, in this latter case, the spindle M is best worked with a lever. [Also see Fig. 614.]

Double Cistern Waste Preventers.

This is illustrated at Fig. 613; it is simply two sets of valves of any kind fixed in one cistern; these valves may be had either single or after-flush arrangements, and are too well illustrated in other parts of this work, such as at Figs. 612, 601, 604, 640, 650, 652, &c., to require further description.

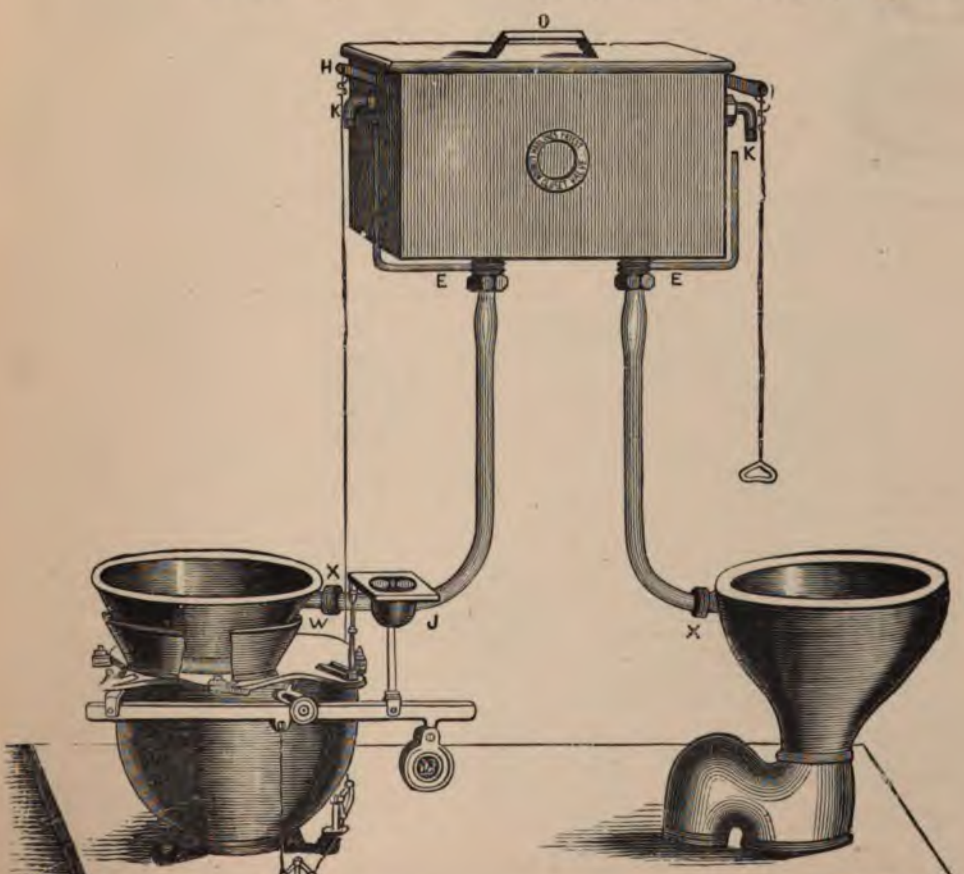


FIG. 613.

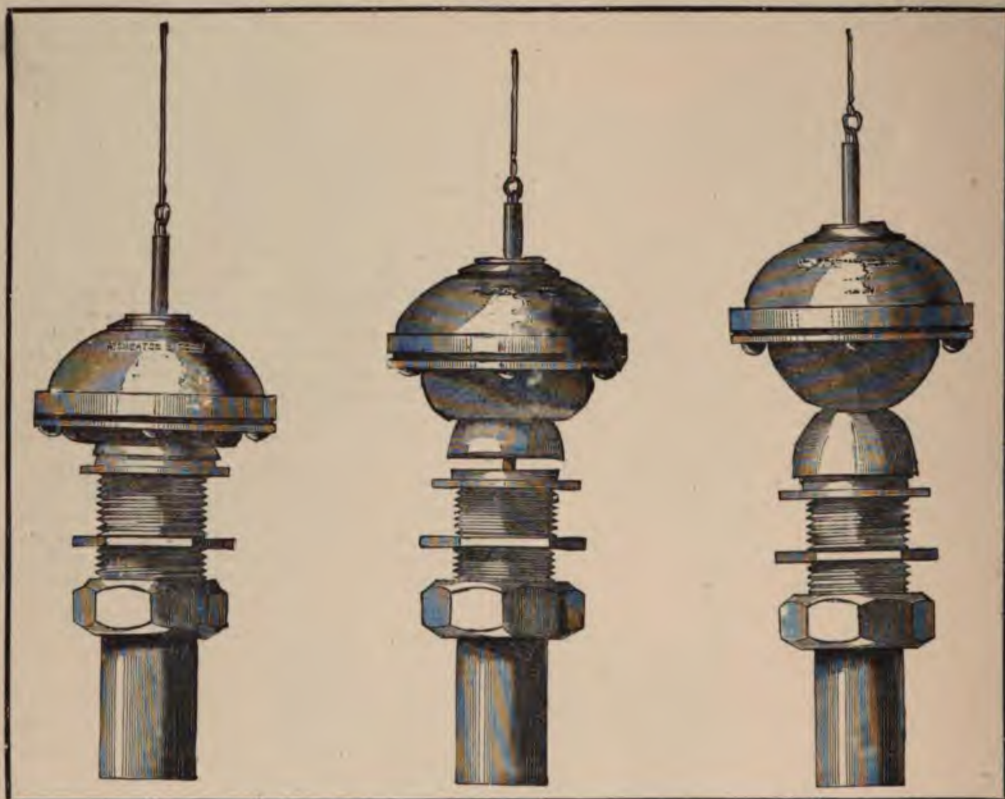


FIG. 614.

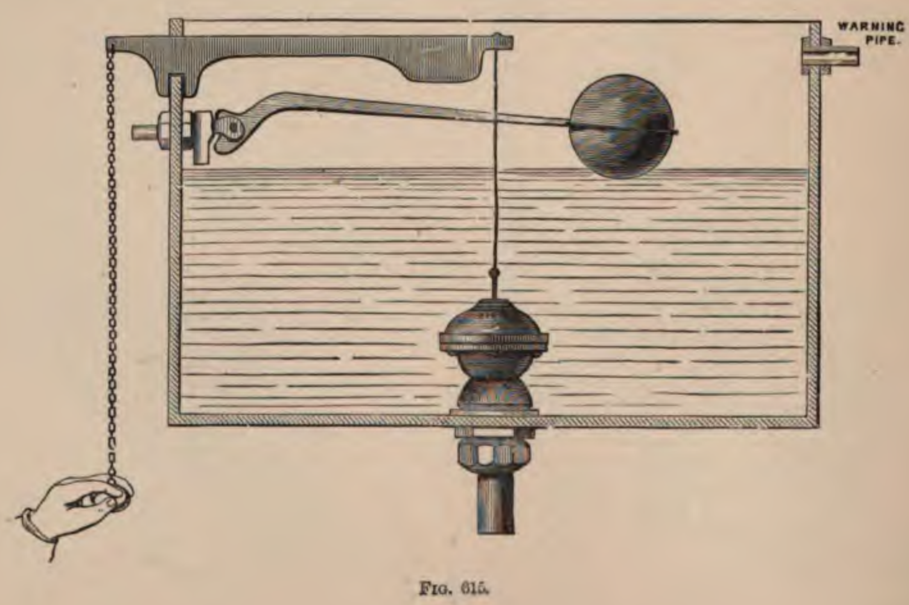


FIG. 615.

Cupped Diaphragm Valve. [Fig. 614.]

On the left hand side is the valve at rest, and is, as can be seen, a flexible cup attached to a weight. At the bottom of this flexible cup there is a valve covering a seating leading to W.C. Pull up the wire at top of weight, and this brings the cup and valve suddenly off its seating, as shown by the middle figure. But as the cup is hollow and flexible, having a small hole for a water passage, the weight of the valve causes it to slowly fall, as shown on the right hand side, thereby closing the valve to W.C., as shown at Fig. 614. Fig. 615 is the same valve fixed in a small cistern, with ball valve, lever and warning pipe complete.

Single and After-Flush Valves.

Fig. 616.—This is the same valve fixed in small cistern. As can be seen, this gives one flush when the handle is pulled, and also one when the handle is let go.

Fig. 617.—This is the same valve as above, made for lead or zinc cisterns, and for fixing over service boxes.

The Frugal Valve, also known as the Triton Valve. Patent No. 1,179 of 1876.

[Figs. 618, 619, 620, 621.]

This invention is simply the adaptation of the well-known boy's sucker to water waste preventing purposes. There is one main point to be kept in view when making this valve, and that is size, for when the rubber C, Fig. 618, etc., is too small, the action cannot so well be depended upon. The parts are as follows: E is the valve seating to W.C. B, a disc, or flat-edged dish, the bottom

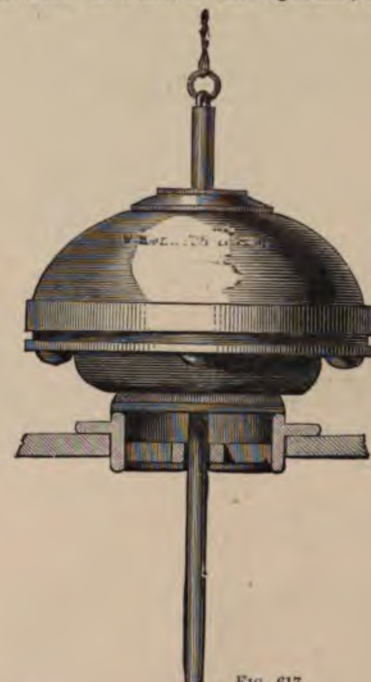


Fig. 617.

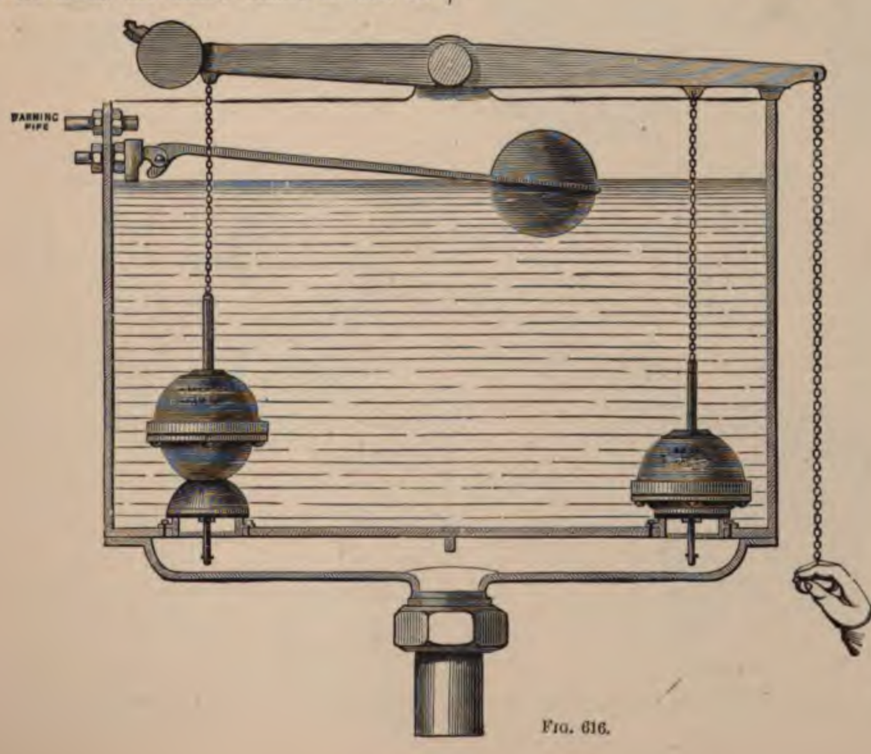


Fig. 616.

of which forms a seating for the seating-rubber. C is the sucker, a piece of pure vulcanized India rubber, 3½ inches round, and one-eighth of an inch thick, having a spindle F, one end screwed for the nut A, and having a small lead weight on its outside, and on top of rubber, or this weight may be formed in conjunction with the attaching weight H. D is the small regulating or relieving set screw into

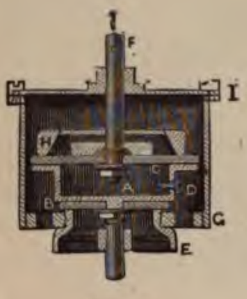


Fig. 618

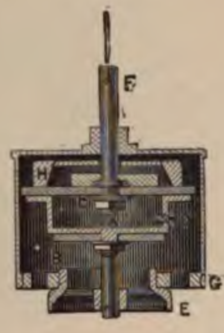


Fig. 619.

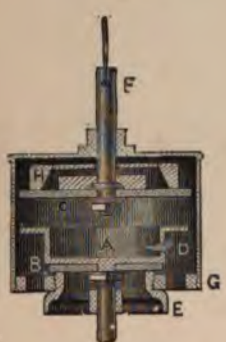


Fig. 620.

Fig. 621

the dish, or, in lieu of this, a small hole will suffice, or, for this purpose, a rough surface will answer on the dish-face, or spiral pipes or rings may be used. G is the outside casing; the water way to the valve is upwards, as at B, Fig. 618, etc.

Fig. 622 shows this valve fixed within a specially con-

Fig. 622.

structed cistern with rounded corners, although here shown with square ones.

The action is as follows: Fig. 618 shows the down pipe valve B closed. The rubber C, Fig. 620, is held up by the spindle F; let this fall upon the dish A as at Fig. 618; now lift the spindle F; this rubber sucker-like takes up the dish A with it, thus opening the valve B, and holds it up as in Fig 619. If the set screw D should be all right, there will be a chance of the dish dropping off, and thus closing the aperture B over the closet pipe. This is soldered to the cistern at the flange E, or it may be fixed over the service box, as the ordinary round valve. See Figs. 597 and 626.

Double-Action Waste-Preventer Valves (Single and After-flush.)

[*Also see* Fig. 563, *&c.*]

The Metropolitan and other water companies' Acts, especially that dated 1871, has created much agitation, and not a little enterprise and inventive talent in the manufacture of water-closet valves, which may very easily be accounted for by reference to the following items in the Act. It will be seen by Clause 21, which I here insert, that the supply of water to closets is limited. It says:—

"Every water-closet cistern or water-closet service-box hereafter fitted, in which water supplied by the company is to be used, shall have an efficient waste-preventing apparatus so constructed as not to be capable of discharging more than two gallons of water at each flush." But it does not make any stipulation as to the number of times you may repeat the flushes. Here is the result: By referring once more to Fig. 628, you will observe the valve-closet, and above it the cistern with the double-action waste-preventing valve, capable of discharging the two gallons twice over, but at different intervals. These after-flush valves should be thoroughly understood by every plumber, for the reason that, like most other water fittings, their good or bad working will, to a great extent, depend upon the treatment

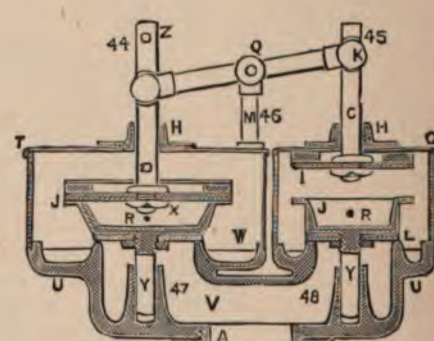


Fig. 623.

they receive from him. Every builder or master plumber should bear this well in mind, as my experience has taught me that half the best sanitary fittings (more especially valves) are spoilt by the clumsiness or carelessness of unskilled workmen.

Fig. 623 is a section of one of the double-action water-waste preventers (for the method of fixing and elevation, see Fig. 628) for fixing in a cistern under water. A is the

tinned seating, to be wiped over the mouth of the down-pipe leading to the W.C., as at 49, Fig. 628. W L, Fig. 623, are the valve-seatings; I and X are the suckers, and J J the sucker plates; R R the regulating-holes, G T the casing.

Next refer to Fig. 624, which illustrates a valve similar to Fig. 623, the difference being that Fig. 624 is for fixing under the seat of a W.C., and consequently the body, shell, or casing must be varied from that shown at Fig. 623, but Fig. 624 may be fixed and used either in or out of a cistern; that is to say, the outlet A of the valve may be screwed to the bottom of the cistern with an ordinary fly or back-nut, or it may be screwed into a pipe; this, though, only under exceptional circumstances, as the cost of the valve at Fig. 624 is nearly double that of 623, in consequence of the extra strength required for the body-shell or casing, and the extra work for stuffing nuts, boxes, &c.

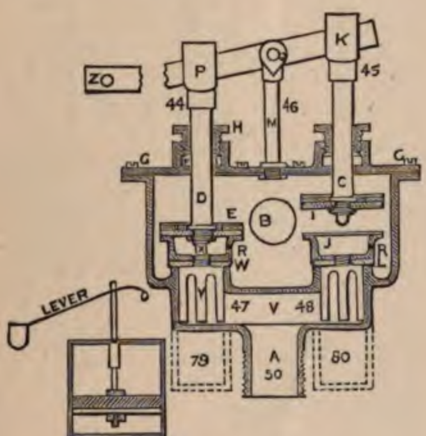


FIG. 624.

The valve W L, when fixed to work under heavy pressure, is made with loose, retarding pistons, and chambers, as shown by the dotted lines at 79 and 80; this is nothing more than a water-cushion or cataract, as shown at the piston and cylinder below LEVER in Fig. 624. The real use of the water-cushion in Fig. 624 is to prevent the slamming of the valves; whilst the use of the same shown in some of the valves to be seen at Figs. 561, 530, 533, 537, &c., is to keep the valve open for a particular period. It also acts as a preventative to slamming. If a flexible diaphragm is used, as illustrated at H, 613, or a ball connected to the valve-dish, the valve cannot drop off, and the valve consequently falls slowly, accordingly as the ball or diaphragm may expand, open, or fall. When this valve is fixed for the after-flush in small cisterns, the one seating may be 6in. higher than the other, so that half the cistern may be emptied *only* for the first flush: and the other half for the after-flush.

Siphon Water Waste-Preventers. (Patent 1,179, A.D. 1876.)

I shall now turn back and see what can be done to make the sucker or other valves more perfect in flushing action, viz., speaking from a sanitary point of view. We saw at Fig. 610 a very perfect valve, but the rendering of its perfect state was due to the use of the siphon; therefore let us see if we cannot contrive with our before examined valves, so that they shall work in conjunction with a siphon. If you like to make an ordinary closet valve to give a set quantity of water at each flush, you can do it by first placing a box in the bottom of a cistern having a smaller hole

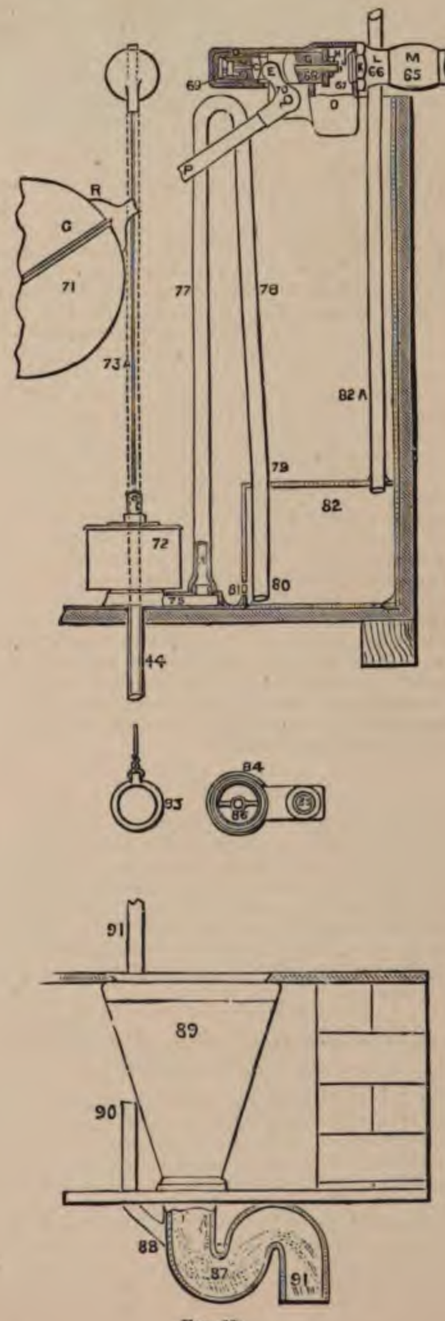


FIG. 625

(in the bottom or side), than that of the down pipe, and an air pipe on top. For such an arrangement see Fig. 625. At 82 is to be seen the box spoken of above; 72 is one of the frugal valves, or this may be an ordinary spindle or round valve fixed over a service box or ends of a down pipe, as shown at M, Fig. 640, and also at 44, Fig. 625; at 75 is the air pipe, which may be in any way connected with the down pipe; but in this case the air pipe is carried up as at 77; bent over at the top and taken down again as at 78 and 79, and finally to within 1in. of the bottom of the box, as at 80. Here it is converted into a siphon; the open end dips into a service-box, as shown at 80; 81 is a small inlet hole, say a quarter the size of the pipe; and 82A, the air-pipe; 73, the ball-lever, 73 A, the wire from the ball-lever to the valve 72; 83 is the pull; 84, 85, 86, is the plan of the valve-seating, showing the bridge and siphon aperture, 85. The effect of this simple arrangement is that the box 82 being submerged, soon fills with water through the small hole 81; the full-sized valve 72 also being submerged, on being lifted allows the water to rush full bore down the pipe 44. Now shut this valve, and for want of air the water rushing down the pipe 44, so to speak, drags the water out of the box 82; by reason of the air-pipe 82A, the box becomes empty, and of course the siphon ceases to run, but it soon fills up again, and is ready for another supply.

N.B.—This is most important. By no means let the down pipe be in any way the least trapped. It must be made to drain itself *quite empty*, otherwise the water will continually *ebb over the siphon*. Be sure and watch this. If the same should leak or ebb over, you will know now how to act. Pan and other closets do not require anything better than this waste preventer, if properly made and attended to. The same applies to all siphon-action closet valves. Of course, the box would not fill or empty itself if the air-pipe 82A, was not fixed. M is the ball-valve, which works with a cup leather within a thimble as at 69; H, K, is the seating; 71 the float. [See Ball Valves, next volume.]

The box of course will only fill up according to the size of the hole 81, which, if large, will allow you to have a smaller box, because the incoming water will tend to keep the siphon supplied with water; in fact, if the hole 81 is too large, the siphon will run a continual stream. Do not forget what I said, that the pipe must not be trapped, but all the water must drain out.

Trap Flushing.

On reference to Fig. 625, at 91, 90 and 88, may be seen a pipe branched into the heel of the trap. This has a wonderful effect in cleansing the trap, especially in workmen's closets; between 90 and 91 is the supply to the arm of the basin, which is continued up to the valve. The effect of carrying this pipe into the heel of the trap is exceedingly good, inasmuch as the water instantly throws everything from the trap into the drain; also see Figs. 480, 551, 395, &c.

Pan-Closet Ventilation, Wiring, and Flushing. Patent 1,179 of 1876.

I have described the siphon arrangement, which is also applicable to valve or pan closets, and shall now fully describe the service-box work, both with and without "trapping or weeping stand-pipes," shown at A, Fig. 626, also at N, Fig. 598, &c. First let us examine the box 30, Fig. 626.

This is an oblong lead service box [see Fig. 578] made tapering so that the bottom may drop through the hole cut in the lead cistern, and the top of the box being made larger prevents it dropping through. Of course, the bottom of the box may be as shown at H D H, Fig. 592, wiped to the bottom of the cistern.

Now examine the valve 33, fixed over the box, also the air-pipe 31, next the down-pipe 28; this pipe runs to the basin 21, and is made good by a putty joint, or it may be

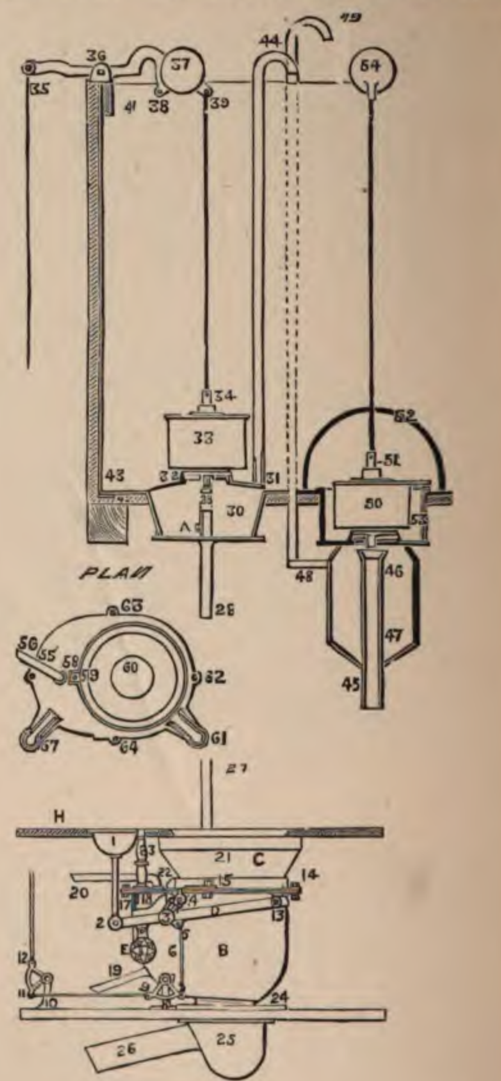


FIG. 626.

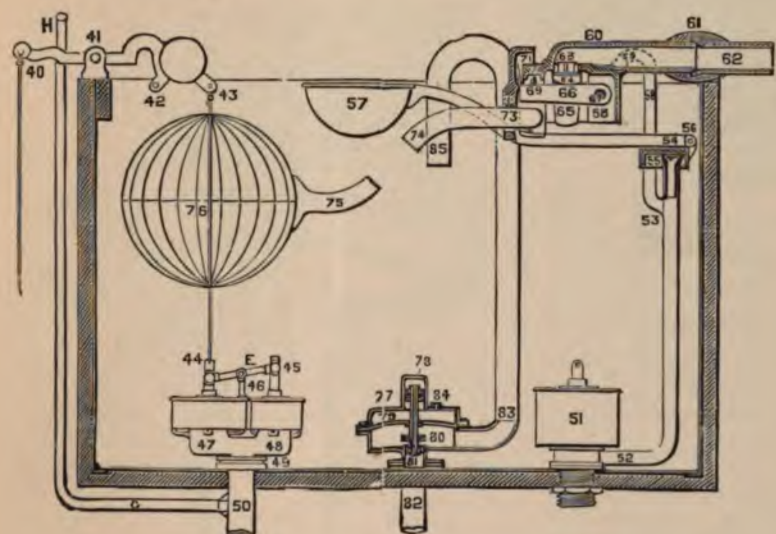
connected to the basin with an india-rubber cone, Fig. 627, and tied with wire.

Closet Cones.

FIG. 627.

CLOSET CONES.—Fig. 627, which is simply a piece of india-rubber pipe made cone shaped, one end to slip over

the arm of the basin, and the other over the pipe, and made good with string or fine copper wire. Next, refer to the top part of the down-pipe at 28, where you will see the pipe brought nearly to the top of the box; the reason for this is, that the valve 33, Fig. 626, is a kind of waste-would, on seeing that the water stopped running, immediately drop the handle, and would be perfectly right, as the small dribble would empty the service box of the running water into the pan. But this kind of stand-pipe is only wanted when waste-preventers are used in connection with valve or pan closets, and when people are apt to hold up the handle longer than necessary.



Cistern Wells.

45, 46, and 47, Fig. 626, illustrate the same kind of stand-pipe service-box, but of different construction. It is generally made of a piece of 4in. soil-pipe [also see Fig. 581], and the ends worked to a tapering shape, or otherwise, at the discretion of the workman. The reason why the valve is fixed below the bottom of the cistern is to allow all the useful effects of the cistern to be utilized. This is known as a Cistern Well; also see Fig. 590.

52, Fig. 626, is a leaden dome-shaped strainer. intended to keep back leaves, &c., from entering and clogging the valve.

Afterflush Submerged Cistern Valves.

[*Also see* Figs. 641, 616, 623, 633, *&c.*]

Turn to Fig. 628 and examine the water supply. 44, 45, 47, 48, is one of the double action waste-preventing valves (for section see Figs. 623 and 624). The action of this waste-preventing valve is this: — that, by pulling up the handle F of the closet, you raise the lever, thus actuating the cranks, ball-lever, and finally the valve-spindle 44; this opens the sucker-valve, which, if held up long enough will drop off, and so the valve will again cover the valve seating; this done, let go the handle, and the sucker valve-spindle will fall back and the lever E will in its turn bring up the other sucker spindle 45, thereby opening the after flush-valve, which after a given time will again drop off and close the seating, but not until the closet-basin is filled up with water, known as the after-flush. G H is the air-pipe branched into the down pipe at 50. When fixing valve-closets, the greatest care is necessary to prevent any hard substance being secreted under the large valve, as it would probably result in the face of the valve being notched or otherwise damaged.

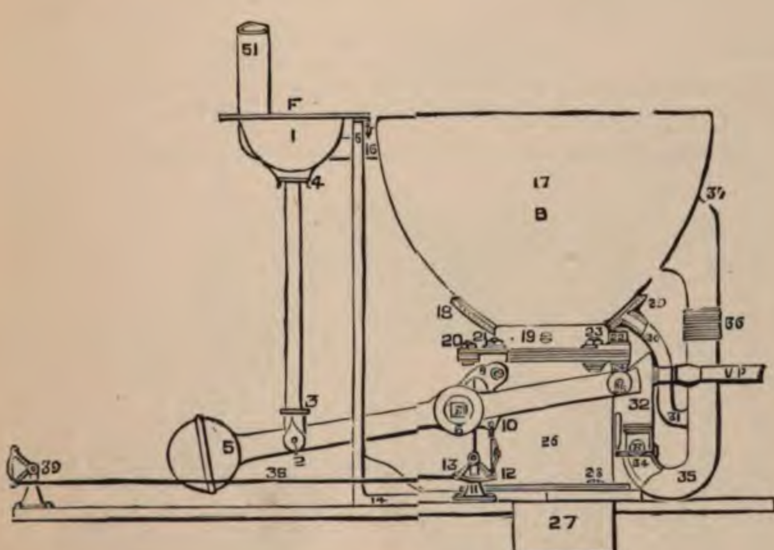


Fig. 628.

preventing valve—that is, that it closes after about two gallons of water is discharged, and should the valve be dropped before the handle of the closet, the water-box, 30, will only empty itself slowly, by reason of the pipe 28 having only a small hole, about ¼in. in diameter, in the side of stand-pipe, as shown at A [for this also see Fig. 581 and description]. Now a very large majority of persons

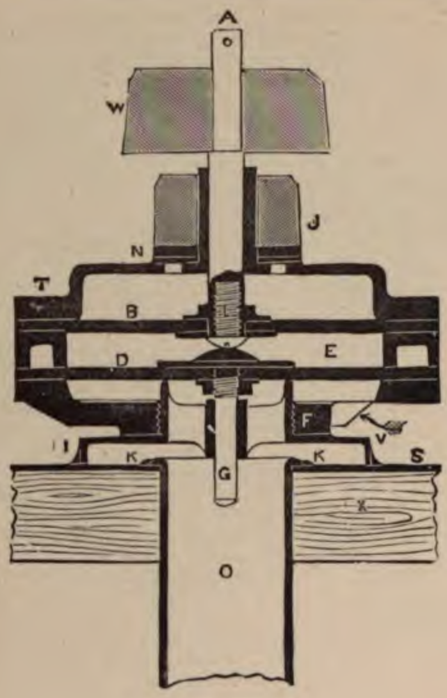


Fig 629.

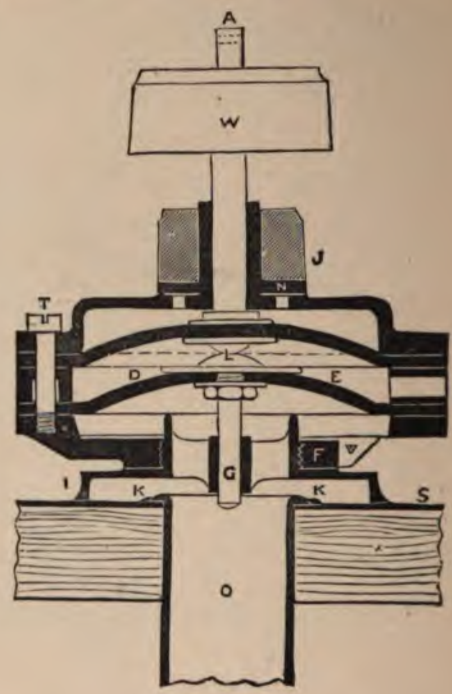


Fig. 630.

Pan Closet Ventilation.

This is illustrated at 19 and 20, Fig. 626, 19 being an inlet for fresh air, and 20 the ventilation pipe. This is a drawing from a pan closet fixed at the Exhibition of 1874, held at South Kensington.

Diaphragm Waste Preventing Valves, known as Lambert's Valves.

The action of these valves will be readily understood when we say that by pulling up the weight, W, Fig. 629, it actuates a disc of rubber, B; this causes suction, and as there is another piece of rubber, D, under the first, by drawing up No. 1, or B, it sucks up No. 2, D, as shown at D E, Fig. 630, and on D is a valve which covers the mouth of the down pipe, F, or sometimes D will answer for a valve. Now between these discs of rubber there is a space for water, E, and an inlet, answering the same purpose as that at D, Fig. 618. This inlet supplies water to the internal parts of the disc, thereby causing them to open wider apart, and thus allowing the lower rubber to go back slowly, and by this means closing the down pipe aperture in a given time.

Fig. 631 illustrates the valve fixed over the mouth of the down pipe, showing the method of tafting the pipe over the cistern lead; it also shows the fixing of the air pipe, whilst that on the right hand side illustrates the valve with metal top.

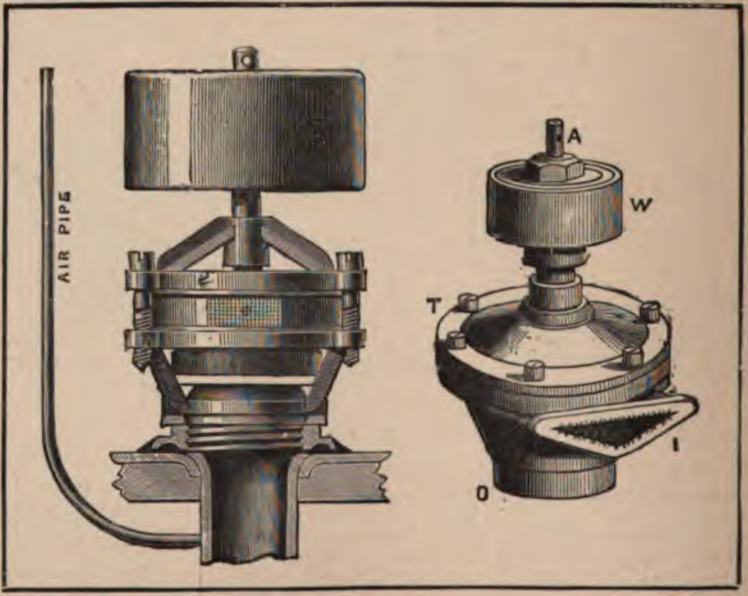


Fig. 631.

Fig. 632 illustrates Lambert's valve in a cistern, as fixed to supply a pan or valve closet. In this case a double action valve is used.

This is one made to work with a short-weighted lever,

FIG. 632.

which, on pulling up the lever, depresses the top diaphragm, and on letting go, it, by reason of the weighted lever, is brought up, when it sucks up the bottom diaphragm and valve, and supplies the closet after the handle is dropped.

Valves, Selection of, for Water Closets.

Of course these valves are in principle exactly the same as those described and illustrated at Figs. 562 and 563, the difference being that one is for fixing in a cistern, and the other for pipes under the closet seat, &c. Sometimes these valves are made one way, and sometimes another; some working with leather, rubber, and even brass or other metal diaphragms; or even with cupped rubber diaphragms. I may add that I was the first to make these waste preventers working upon the principle of suction, and fixed them as early as 1868, when at work as foreman plumber to Mr. John Jay, the well-known contractor. I also made other kinds, such as those working with piston and diaphragm, also with two pistons, after which a cock was patented. Then Tylor's people patented; then I patented, and sold my patent to Tylor, and which is now the well-known *submerged* waste-not valve. Lambert afterwards patented for diaphragms. After this scores have patented the same thing over and over again.

Now it should be distinctly borne in mind, that these valves are all useful at times for certain work, and under certain conditions. For instance, it would be foolery for a plumber to fix such a valve as that shown at the section, Fig. 562, for very high service or pressure, say for two to four hundred feet; here the top diaphragm could not to expected to stand, and therefore a suitable valve should be selected, and that which perhaps would come first, is that shown at Fig. 561, which has a spindle T and stuffing box, instead of the diaphragm B, Fig. 562; and for places where higher working pressures are found, a cup leather can be employed, as in the ram of a hydraulic press, or that of a pump. On the other hand, suppose you to have only a very low pressure, say from five to ten or fifteen feet, then perhaps the diaphragm pattern, Fig. 562, will work better than the stuffing box pattern; at any rate it would cost less to make, and these are the points worthy of every plumber's consideration.

After Flush Diaphragm Cistern Valves.

This valve Fig. 633 is similar in construction to those shown at Figs. 629 and 630. In fact these two valves may be considered a kind of after flush valve, owing to the valve N acting when the spindle is dropped; but in Fig. 633 there is an additional diaphragm or metal disc between the internal part of D E, Fig. 629. This metal disc has a relief valve which opens upwards, but on the descent of the diaphragm D, Fig. 629, the relief valve in the metal disc closes, and so checks the diaphragm D from returning rapidly. In other words, the valve Fig. 633 acts exactly as those described at Figs. 641 and 642, the difference being that Fig. 633 is made with flexible diaphragms working one above the other, with suitable water passages and valves.

Plunger and Diaphragm Valves.

This valve is shown at Fig. 634, and its principle will be readily understood from the following:—B is a plunger, D the diaphragm. On pulling up the plunger B, it tends to give room to the internal part of the valve, but as the diaphragm D is free to move in an upward direction, it follows the plunger and so opens the valve H; but as the sides of the plunger do not absolutely fit the cylinder, the water percolates to the under side of the piston, which refills the space, E D, and allows the diaphragm D, with its valve H, to slowly descend to again cover the valve seating. On dropping the spindle the plunger presses the water out from below through the relief valve N J, and is ready for use again.

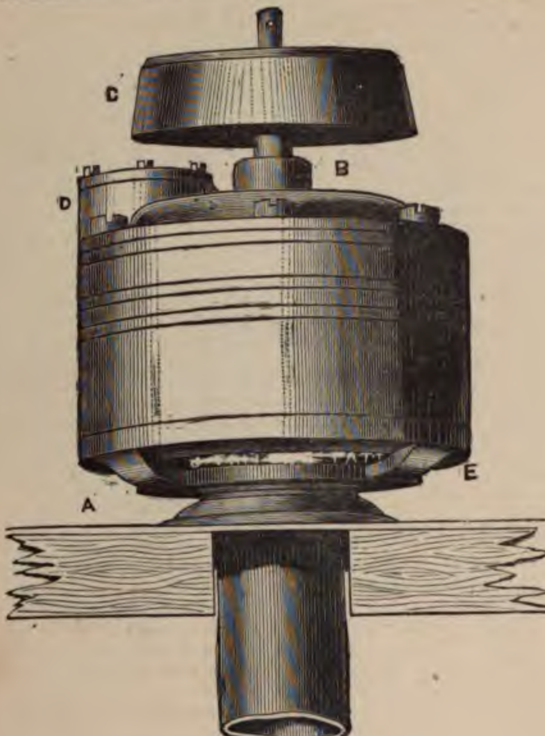


Fig. 633.

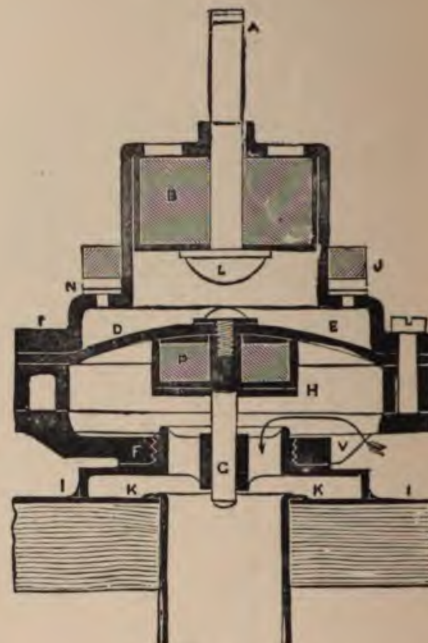


Fig. 634.

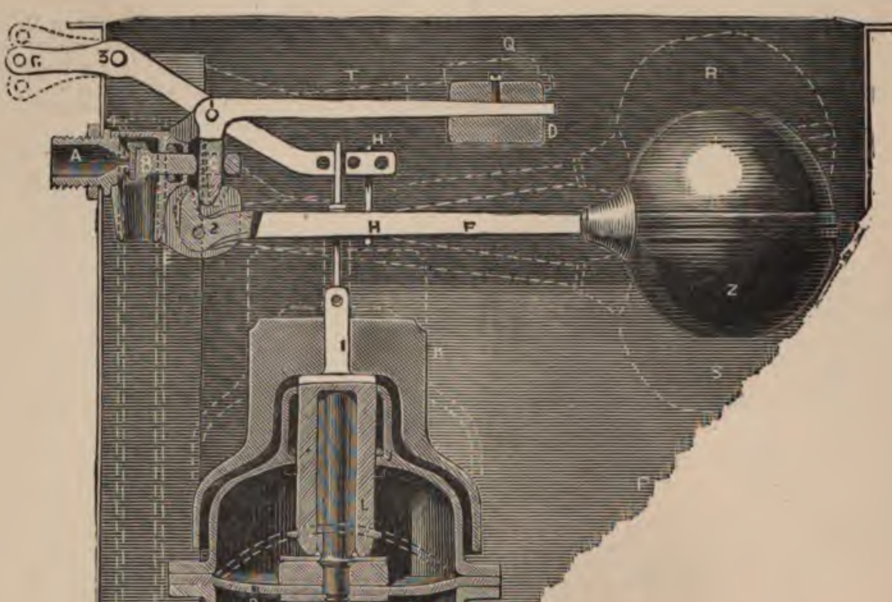


Fig. 635.

Piston and Diaphragm Valves.

Patent 1,179 *of* 1876.

This is shown at 9, M, L, J, I, Fig. 635. After what has been written on Fig. 634, this valve, Fig. 635, will be readily understood. 9 M is the diaphragm, having a valve at the bottom and a weight on top, through which passes the spindle L, which works through the guide piston-rod I, which is weighted by the weight K. Round this valve. For the action of this Ball Valve, H, F, Q, T, &c., Fig. 635, see Waste Preventing Ball Valve Attachments, Figs. 635, 645, 646, and 647.

Self-Acting Waste Preventing Cistern.

[*Known as The Automatic Flushing Cistern.*]

Patent 1,179 *of* 1876.

This will be understood from the following description:—A, Fig. 636, is a regulating screw-down stop-cock, and the

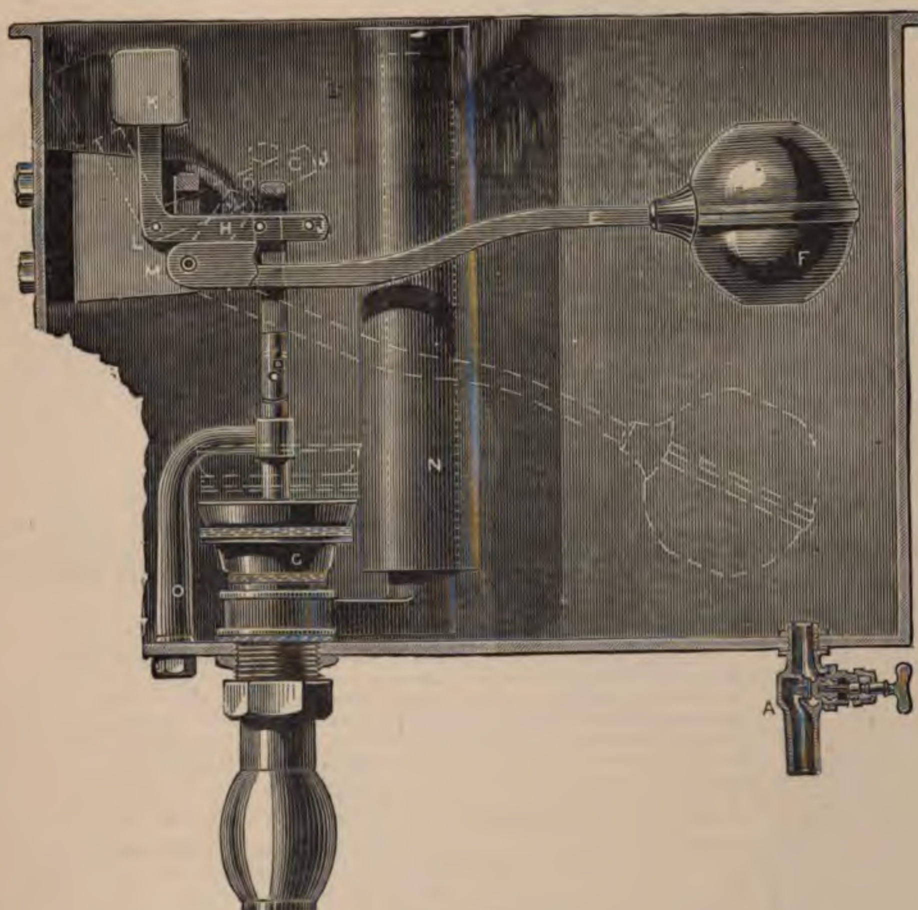


FIG. 636.

spindle L and at J may be seen a little rolable ring made of indiarubber, this ring being for the purpose of packing the joint round the spindle. It will be seen that by pulling up the piston I and L, that it acts as a pump plunger, and will draw up the diaphragm valve 9 M into the body of the valve, as shown by the dotted lines; but owing to the small aperture at 9, the diaphragm again descends, and so covers the valve seating. At N O is to be seen a passage which terminates in the shape of a siphon, so that the cistern is emptied at each working of the

inlet valve to cistern, C the outlet valve, F the float attached to the rod E, and which is centered at M.

H is a short arm fixed on the lever or rod E, having a slot cut through same for the kicking-lever J to work through. J is centered at L. K is the balance weight for holding up the valve C; N, the siphon; O, the guide for the frugal valve C. The action is as follows:—Turn on the water at A, the float F rises with the water, but does not much interfere with the kicking-lever J until the cistern is nearly full; it then begins to move, and as the

float rises, so does the kicking-lever J and also accelerates its motion against that of the rod or lever E. When the float rises to a certain point the kicking-lever is overbalanced by the balance-weight K, and thus kicks or pulls up the valve, as shown by the dotted lines, which allows the water to run out of the cistern, and to bring the siphon N into action. The float now falls with the water, and the lever of same pulls back the short lever J, together with the balance-weight, and is soon ready for another action.

There are many other methods of attaining this very same object, and much more simple than the above. It can be done with a siphon alone by letting it through the side of a tank, say, 3 inches from top. Let the long leg be four or five times longer than the short one; now fill the cistern, and in proportion to the size of siphon to the income of water, so will be the time occupied in emptying the tank.

Another and very simple one can be made with a ball-cock or ball-valve. Fix a ball-cock in a cistern having a siphon, as just suggested; let it be fixed so that when the ball is at the bottom of the cistern the water just dribbles in, but as it fills the cistern up, it allows the water to come in faster (quite the reverse of the general order for regulating the supply of water to cisterns). The water rising fast, and above the top of siphon, soon puts the siphon into action, when, as before, it empties the cistern in proportion to the outgo and income, or size or height of the pipe.

As before said, there may be many methods to arrive at this same point. For instance, a double trapped pipe, as shown in patent 1,579, dated A.D. 1873, and delineated at Fig. 670, plainly shows the original of a siphonic action flushing tank, which so much fuss has been made of lately, and which people, of apparently high social position, are claiming as their invention, although they have fettered themselves with specifications for letters patent after the date of 1873. Again, an automatic flushing arrangement with siphonic action can be seen in the cistern at Fig. 511, which works exceedingly well.

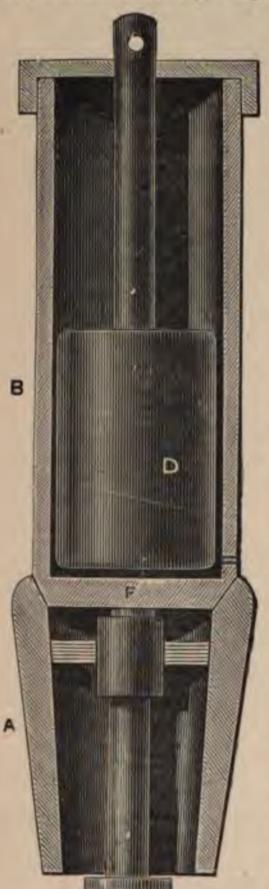


Fig. 637.

Plunger and Cylinder Submerged Waste-Preventing Valves.

Patent 2,838, A.D. 1872.

This is a valve, shown at Fig. 637, which is actuated by means of a plunger or piston D, loosely working within a cylinder, B, containing a liquid. It will be readily seen that if the cylinder contains a liquid above the piston D, that on pulling up the piston the fluid above will gradually run down between the sides of the cylinder and piston to the space below, and allow the cylinder to gradually descend, thereby closing the valve F, the time which the cylinder is falling being regulated by the amount of fit round the sides of the piston, together with the length of the sides of the piston. For argument sake, suppose the piston to be only a very thin one, as shown at D, Fig. 638; then the water will readily pass from above to below, by reason that there is less friction round the sides; but increase the length of this piston to that of D, Fig. 637 (of course, keeping the diameter the same),

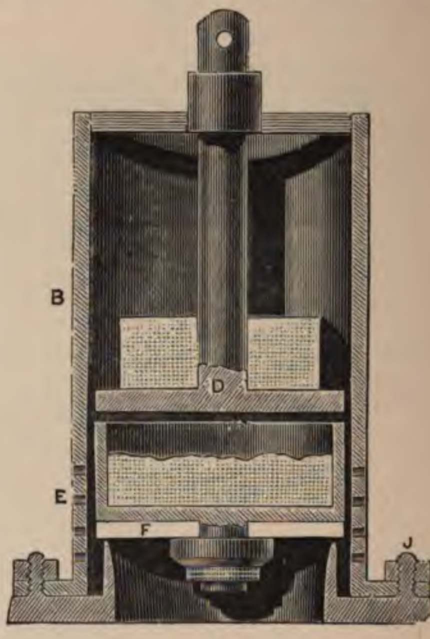


Fig. 638.

and in proportion to the additional length, so will be the time during which the cylinder B will be in falling. Of course, the valve F, Fig. 637, may have the piston attached to its top, as shown at B, Fig. 640, and the cylinder made loose like an inverted cup, and so fitted to actuate the piston when the cylinder is inverted.

Waste-not Valves.

These valves have been very extensively used under the name of the Waste-not valve, manufactured by J. Tylor and Sons, Fig. 638 being the pattern generally employed. The action is as follows:—F is the down pipe valve; D, the plunger or piston; B, the cylinder. When under water, by raising the plunger D, the valve F is pumped up, and the outlet orifice to the closet opened. The water then runs through the holes or strainer E, during which time the clack valve F descends, and slowly shuts this off. Let go the plunger, and the valve is ready for another supply—that is, of course, after the plunger has fallen. This valve has been made in thousands of different ways, and the infringers are legion throughout the world. The way to fix this valve is to unscrew the tube, take out the clack or valve, and solder the ring H to the service box or over the down pipe in cistern. This valve is made for any cisterns—slate, iron, etc. Of course, as before remarked, there may be thousands of different shapes, one more of which I will give, as the principle is very useful

to the student in pump work. This, Fig. 638, is very liable to fur up and stick in some kinds of water, on account of the tightness of the fit, etc. Fig. 639 obviates this to a great extent. The longer and the more surface there is given to the pistons, the longer is the water passing between the sides, on account of the extra friction, and, therefore, the more water can be obtained at each flush.

The Telescope Waste Preventer.

This valve, Fig. 639, is a very great deal better than the last-named valve, inasmuch as the valve F has a better chance to work in the tube or cylinder, L. It is larger, and the working parts of the cylinder may be entirely used by the clack. It will at once be seen that on the whole being submerged under water, and on lifting the outside tube, the top valve M must open, when up pops the clack or outlet valve F; the water runs down the closet pipe N; but release the outside tube quickly, and the top clack M closes, thereby preventing the outlet clack suddenly closing, and allows it to go slowly back to the outlet seating, by reason of the slackness of the falling valve F within the cylinder. You see that in this valve you cannot get a larger or a less quantity of water at each operation of the pull—a very necessary acquisition for all closets. The way to repair these valves is, by re-leathering the clacks. It is the best *close fitting* inferential waste-preventing valve extant. This valve cylinder L screws into the ring D, instead of having the flange at J, Fig. 638.

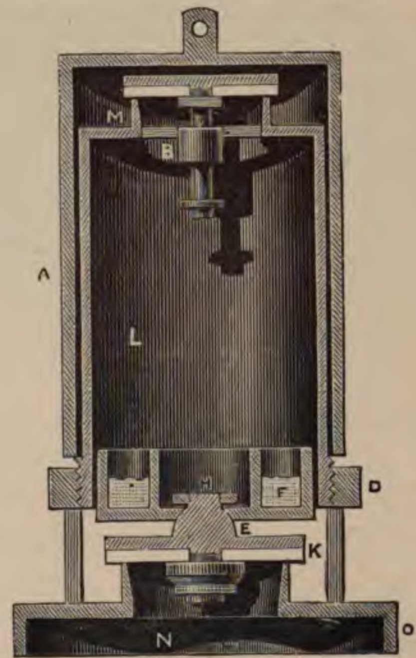


FIG. 639.

Siphon Action "Waste Not" Valves.

Fig. 640 illustrates a siphonic action "waste not" valve fitted to a service box K. The parts are as follows, M is the down pipe to W.C.; C the plunger or piston, as at D, Fig. 637, but with the cylinder inverted; B the valve seating; D the cylinder; A G I is the siphon; K the 2 gallon or other service box; J the $\frac{1}{2}$in. inlet hole. H (which is by the engraver drawn too small) is the air pipe,

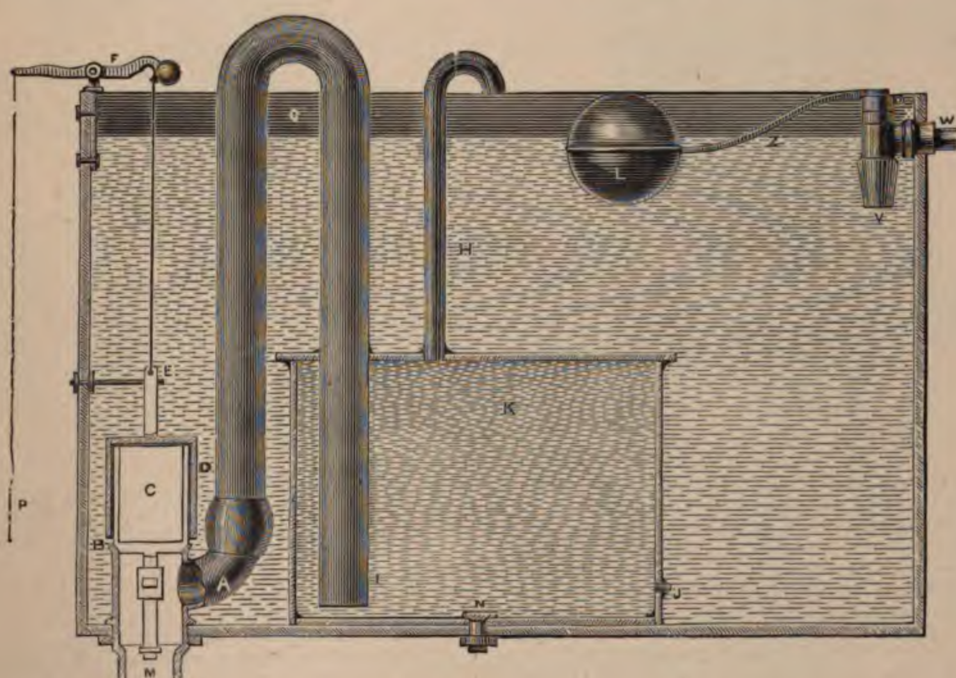


FIG. 640.

the size of which must be the same as the down pipe. The action is as follows: On pulling up the loose cup D, it sucks up the plunger C, and with it the outlet valve B, when water runs from the large tank to the W.C., but if you hold the handle too long the piston C by reason of its slack fit gradually descends, also the outlet valve, which is say now closed; there being no air pipe to let the water out of the down pipe, the siphon begins to play, and by reason of the air pipe H, quickly empties the box K; because the inlet hole is not quarter large enough to supply the siphon, air is admitted and the siphonic action is broken, but not until the contents of the box has passed down to the W.C.

After Flush or Double Acting Waste Preventer for Service Boxes.

[*Also see* Fig. 628.]

This valve Fig. 641 is simply a valve actuated by a double acting plunger, A, and as this will lead the young plumber into the right path of hydraulics, I ask him to study same at leisure—as all of these diagrams will be useful in this direction by-and-bye. More especially do I ask the young workman to study these waste preventers

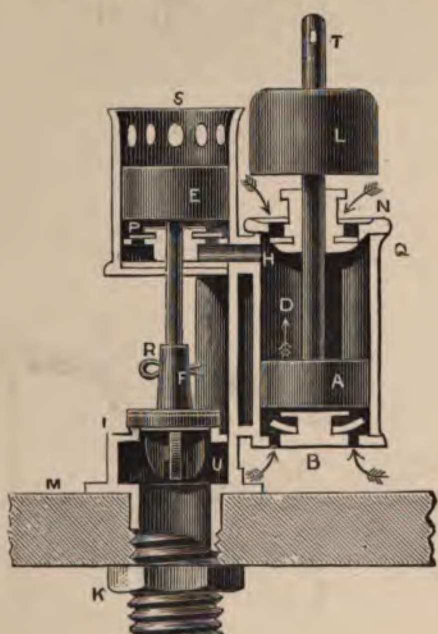


Fig. 641.

in order to impress upon his mind the proverb, "There is no new thing under the sun." These old inventions are, and still will be, new and useful to the rising generations. Now, some of these devices used in connection with these water waste preventers are of very old date—long before the Middle Ages, and what would you say if I tell you that thousands, aye, hundreds of thousands, think them not more than forty years old? Pray take this as a friendly warning, if you happen to see a way to improve this or that, do not follow the example of others by budding it up unt[illegible] have saved enough money to buy a patent, but read and get all books you can treating upon the subject of your new idea, asking all questions relating to the same, especially through the wide field of scientific journals; but don't say what you are doing, and it is a thousand to one but you will find something quite near enough to save your money. Look at the actuating principles of Figs. 641 and 642. It is a double acting piston A, which passes up and down the cylinder D, having valves, N B, at each end exactly as those which have been used by the Chinese from time immemorial. Now as waste preventers have had an immense run of sixteen years at least in London, who can say how many

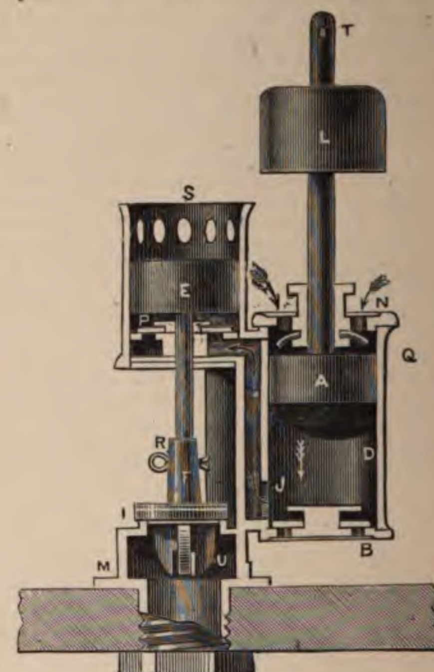


Fig. 642.

times all the before recorded figures have been re-invented, as every plumber more or less has inventions of his own? Many will say that I can soon find out the first by applying at the Patent Office, but a greater mistake was never made, for the far greater part of our patented articles are as old as the Patent Office itself. Bramah was supposed to be the first to apply the cup leather round the piston-pole or ram, but he had no more legitimate claim to that invention than I had, for this is recorded by more than one, two, or three persons, long before Bramah was born, more especially before the date of his press, 9th May, 1785.

The Fig. 641 works as follows:—A is the actuating piston, working within the cylinder D, H is a water-way leading to the underside of the valve piston E. It is evident that if there be water in the cylinder D, and also in the water-way H, that if you pull up the piston A, all the water will fly before it, and that if the valve N closes before the water, the latter will rush up the water-way H, and try to pass the piston E; but, as this piston fits the second cylinder S, and is free to move up same, the water raises same, carrying with it the outlet valve I, which allows the water to flush the W.C.; but, as the piston E does not fit the cylinder, the piston slowly

descends and stops off the water with the valve I; but, as the upward pull is only half the operation of the closet, on leaving go the handle the plunger or piston A falls, and again forces the water from below, as shown at J, Fig. 642. This passage J also leads to the underside of the piston E, and causes it again to pop up, thus giving another flush to the W.C., known as the after flush. This is an after-flush proper, as it cannot be obtained until after the handle is let go.

I need not say that you, on pulling the piston A up, first close the valve N, also a valve in the water-way J, and open the valve B; and when the piston descends it closes B and the valve in the water-way H, and opens N.

Bolding's Waste Preventer.

Fig. 643 illustrates a waste preventing cistern, dependent upon the limited supply through the ball valve for its waste preventing properties, but whatever I may think about this being a waste preventing cistern, I may say that this is not the only one which is made by the above firm, for they make some of the very best, many of which are illustrated in this work.

FIG. 643.

Stone and Co.'s Waste Preventers.

Fig. 644.—This valve is known as "Stone's London Waste Preventer." To a certain extent it depends upon a float for its action. The valve is a kind of float, but is actuated on well-known hydraulic principles—in fact, it is a small pump in action, with the clack in a semi-floating condition. The spindle is actuated by the lever, and of course the float is actuated by the spindle or piston, by the displacement of a certain amount of liquid, when in a given time the float falls back upon the aperture of the down pipe.

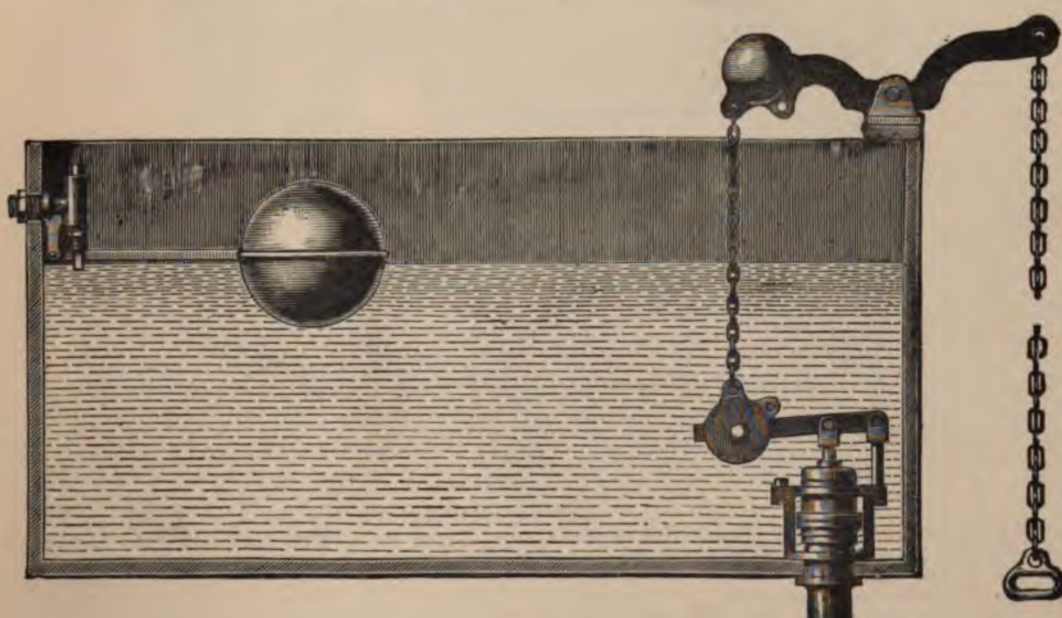
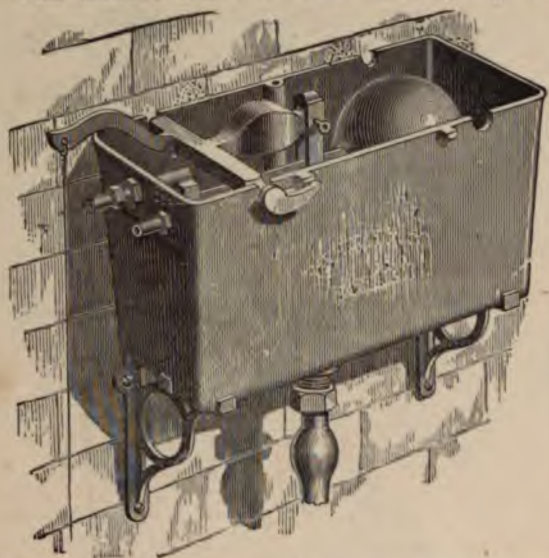


FIG. 644.

Waste Preventing Cisterns with Ball Valve Shut Offs.

This cistern is illustrated in the following diagram.



This is one of the simplest waste-preventer cisterns made, but as this cistern requires a special made ball-valve it is, as a rule, not allowed to be fixed by the Water Companies, on account of the ball-valve so readily getting out of order. This will easily be understood from the following account: The ball-valve is attached to the lever of the waste-preventer, and by pulling this lever, it first brings up the stem of the ball-valve and shuts off the incoming water, and by continuing the pull it strains the stem of the ball-valve; and then by additional pulling it opens the outlet-valve. You will observe that by this continual pulling of the ball-valve stem, it must of necessity injure the rubber of the ball-valve, and, therefore, the work is imperfect.

Some years ago the Water Companies set their back up against this class of ball-valve arrangement, and issued orders that no cistern would be allowed which did not allow the ball-valve to work quite independent of the outlet valve; but no sooner were their orders issued than the inventive faculties of some plumber were at work to arrange a double plugged ball cock. One plug was actuated by the ordinary water-ball, whilst the other plug was actuated by the lever, and which was actuated by the ordinary outlet-valve lever, and thus the Water Companies were again beaten; but to simplify matters Mr. Morris, of the Kent Water Works, set to work and designed a ball-valve which rectified the evil of the rubber cutting nuisance. The following cistern is fitted with such a valve, the section of which is shown at Fig. 646, also at Fig. 647.

Stone's Waste Preventing Cistern (Single Action).

Fig. 645 is a perfect water waste-preventer of the simplest kind, namely, a box having a valve in the bottom of same, which cannot be opened until the inlet or ball-valve to same is closed.

You will see that this box is so constructed that, although only possessing one inlet valve and one discharge valve, it yet contains all the advantages of the more expensive and complicated double-chambered cisterns, excepting after-flush affairs. It is, as can be seen, arranged so that when the water is required to be drawn off from the cistern, the inlet valve leading from the source of supply is perfectly closed before the discharge valve can be commenced to be opened, for section of which see Fig. 646. This ball-valve makes the box complete.

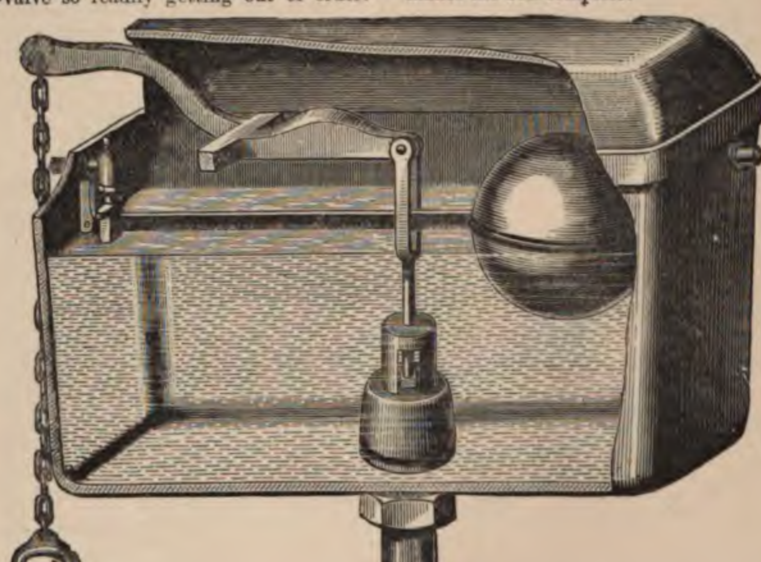


FIG. 645

Other Ball Valve Arrangements for Waste Preventing Cisterns.

Of course I do not mean to infer that there are no other ball valves which will answer the purpose of Figs. 646 and 647, as there is Frost's ball valve, perhaps the first ball

valves made that could be pulled up without cutting the rubber; then again there is that shown at Fig. 635, etc. Besides, a common ground-in plug cock can be worked very well, as the plug is free to move a long distance past the shutting off point; but there is a great difficulty in making and maintaining the plug cock sound, especially under high pressure, and if fixed under the latter the plug has to be screwed up so tight as to make it work too stiff and heavy for the other working parts of the apparatus.

Ball Valves for Waste Preventing Cisterns.

By referring to Fig. 646, it will be seen that the ball-valve is the well-known pattern of Eskholme and Wilkes's patent. A is the inlet, E the tube, having a seating at the upper end. This tube is actuated by the raising or lowering of the float rod N, working on the link H, forming a lever of the second order. M is the valve clack, which is free to move up and down in the top of the body of the valve; it also rests upon the bridge G, which takes the pressure of the tube; this is very important, as the fact of this makes the valve an equilibrium. K is the leather. It is a piece of stamped-up leather answering the purpose of a tube washer, and is held in its place by the jamb screw L;

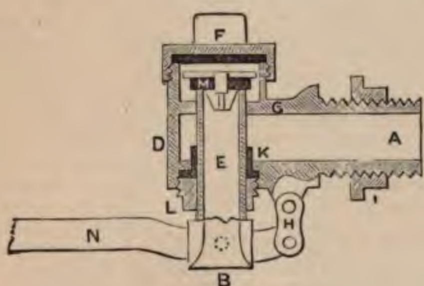


FIG. 646

F is the cap to take the clack or valve out. (By-the-bye, this is rather a tedious job at times, as you cannot very well pick the valve up. To do this easily, dry the top of the valve, and place a bit of putty upon same, and this will fetch it up without any trouble.) Now let us examine its action: The water drives in at A, the valve tube E is down below the bridge G, and there is a free passage for the water. You see that the tube-washer K fits the tube, E, so that no water can pass this way, and the stronger the pressure the tighter the washer fits the tube. Now, pull up the float rod N; this brings up the tube through the bridge G, and to the underside of the clack, or valve face M, as shown. It takes the valve up: what then? The water-way through E is stopped off. Now continue to pull, and the clack is carried on top of tube up the body of the valve and cannot become cut. Let go the rod and the tube drops, leaving the valve above the bridge, when the water-way is again established.

In this ball valve, Fig. 646, the advantage is, that you may pull up the rod of the ball valve without cutting the rubber with the seating. This could be accomplished by the use of a ball valve invented by Mr. Frost, known as Frost's Patent, but this is not an equilibrium; besides, if a lead shaving should happen to get into the Frost's valve, it is a hundred to one if it can get away, because the way is next to blocked up with the spindle of the valve, &c., to say nothing of its only opening less than one-eighth of an inch; also see the ball valve in Fig. 635.

Osborne's & Morris's Ball Valve.

Another ball valve, having all the properties of Osborne and Peerless's Patent Equilibrium Ball Valve, is shown at Fig. 647, and is a valve specially constructed, so that the

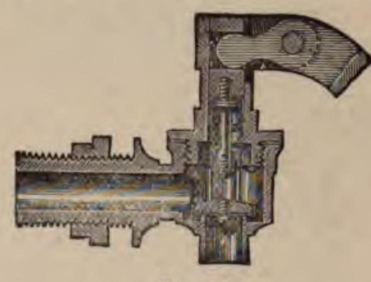


FIG. 647.

pressure from the main pipe is on the back of the valve, thereby ensuring its perfect soundness. This is not retained in Fig. 645.

Waste Preventing Ball Valve Attachments.

At Fig. 635 is to be seen an improved kind of ball valve, suitable for waste preventing cisterns, having one valve situated in the bottom as at M, but with this ball valve attachment any kind of outlet valve may be employed, such as a simple spindle valve, &c. The action of this ball valve is as follows:—Suppose the outlet valve of the cistern to be attached to the lever pull, as at H, pull up the outlet valve in the ordinary manner, and the cistern would supply water to the W.C. as long as any could run through the ball valve, so that, in order, with such a valve, to prevent waste, the inlet must be shut off, and by pulling up the rod of an ordinary ball valve this would answer, but by pulling this valve the rubber is apt to become cut by the seating, and so the valve, in time, becomes destroyed; but with the ball valve shown at Fig. 635, a person pulling up the stem of the ball valve has no control over closing the inlet valve, inasmuch as the end of the ball rod, at 2, is crooked and coggle jointed, and can only act on the end of the weighted lever (which controls the spindle of the valve) in one direction downwards; that is, when the ball is allowed to fall, its coggle joint at 2 presses upon the end of the weighted lever, and so opens the valve, but pull up the ball as shown by the dotted lines at R, and the ball rod will be out of control, so that in this case the stem or rod of the ball may be connected to the lever H, and the lever H to a spindle valve, when you can get perfect shutting off of the inlet to cistern before the outlet valve is attempted to be opened.

Having seen the action of this ball valve, I will next introduce a waste preventer which is not quite so intricate.

Double Valve Boxes or Cisterns.

These valves and boxes are well-known to nearly all plumbers, but the different sorts and manufacture are legion; therefore, I shall only pick out those which have stood the best test.

Fig. 648 is a sectional elevation of Stone and Co.'s large sized double-chambered waste preventer box or cistern, and Fig. 649 is a plan of same. You see in this figure you have the well-known Osborne and Peerless's Patent Ball Valve, which has been described. Just under the inlet from the ball valve is the first valve, which regulates the water from above to below, or from the first chamber to the second, wherein the large valve works in bottom chamber, or, in other words, the outlet valve to W.C. Now, by first pulling the lever, it first closes the valve in the top

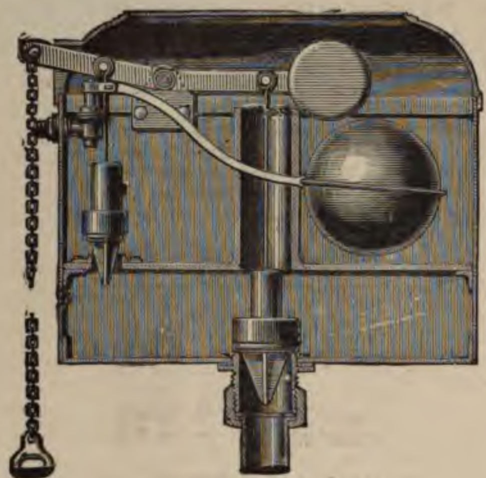


FIG. 648

chamber, and by continuing to pull, the lever passes through space known as lost motion, without first actuating the second valve, and as the pull is continued, so will the lever take up the second, or outlet valve, and allow the

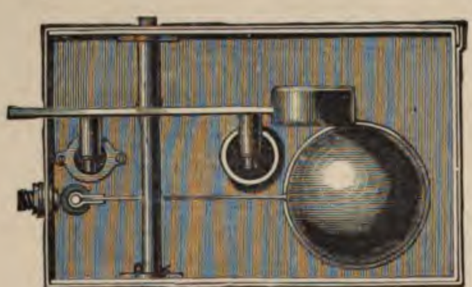


FIG. 649.

contents of the second chamber to flow and flush the W.C. Let go the chain, and the outlet valve first closes, and allows the first valve to again open, and so on. These cisterns, when made of cast iron, are made with taper sides and rounded corners, so as to reduce the risk of fracture by frost to a minimum. The same cistern is also fitted with other ball valves if required, or with an additional service box or chamber, with weeping pipe for valve or pan closets.

Double Valve and Afterflush Cistern with Cataract and Siphon Arrangement.

[*Patent* 1,179. *A.D.* 1876.]

This cistern was designed for the New River Water Company, in the year 1872, but without the use of the frugal valve W, which was patented in the year 1876. K is a regulator which has been applied to hundreds of different purposes, even in the Cornish Steam Engine. [See Bourne, on the "Steam Engine."]

This waste-preventing service-box, Fig. 650, is fitted on purpose to show three different movements. A is the inlet service-box, wherein works the ball valve; also the valve D, which, it will be perceived, is resting upon its seatings E, thereby cutting off the communication between the box A, and the box C. If you look at the rod F, you will at once see that it passes through the lever G, and can be only moved one way, no matter how far you may pull this lever down. Now on examining H, you see that the lever takes up the valve I, and as long as you hold the lever down so it will hold up this valve, but let go suddenly, and something else comes into play. It is the cataract J. The action is just that of the jack or other pump. By depressing the lever G, it brings down the piston or diaphragm in the cylinder K, by reason of the valve L opening upwards, &c. Of course this closes the valve D, and opens I. Now let go this lever, and the cup leather or packing on the piston working within the cylinder opens or expands or gives, and prevents the lever going back; but let there be a small hole through the bottom of the cylinder, as at M, and the water will rush through same to fill the space below the piston and cylinder (or in lieu of water air will answer here), and in proportion to the size of this hole so will the lever go back, taking the outlet valve I, with it. This is the subject of a patent. I should here remark that it was worked out during the years 1871 to 1876, and made to work with mercury, oil, air, and, as you see, the best with water, sometimes using pistons, bellows, diaphragms, &c., for the actuating or retarding parts.

The method of illustrating the "lost motion" with levers is here shown very plainly. The reader will see the outlet valve I, is just seated, and the lever is in the act of taking up the valve D, but before it can take up D, the lever has to pass through space called lost motion. There is a novelty in this siphon. The pipe Q communicates with the down pipe V. It may also be seen that on the pipe R there is a small box-pipe T; this pipe or box has an opening in the bottom U; it also has one at the top S 2, which communicates with the inside of the pipe R.

The use of this is of more importance than my readers may think—in fact, this is a masterpiece with waste-preventing service-box siphons, and is the work of fully twenty years. It effectually prevents the siphon ebbing when the closet pipe is trapped, by giving air to the siphon when the box C is filling, as follows:—

Suppose the box C to be full of water to the middle of the box pipe T. Pull the lever down and open the valve I; suddenly let go (the cataract to be disconnected); the siphon comes into operation and takes all the water from the box C. Now the siphon is done, and the tubes are empty, and require a little more air than has been taken in. During the time the outlet box C is filling, the box-pipe T empties itself through the aperture U, and thus supplies the necessary quantity of air; but when the water rises up to the box tube U, it again fills this box, and is ready for another operation. It may be said that a small hole in the siphon will answer without this box tube; so it will for a time, but as this aperture has to be so

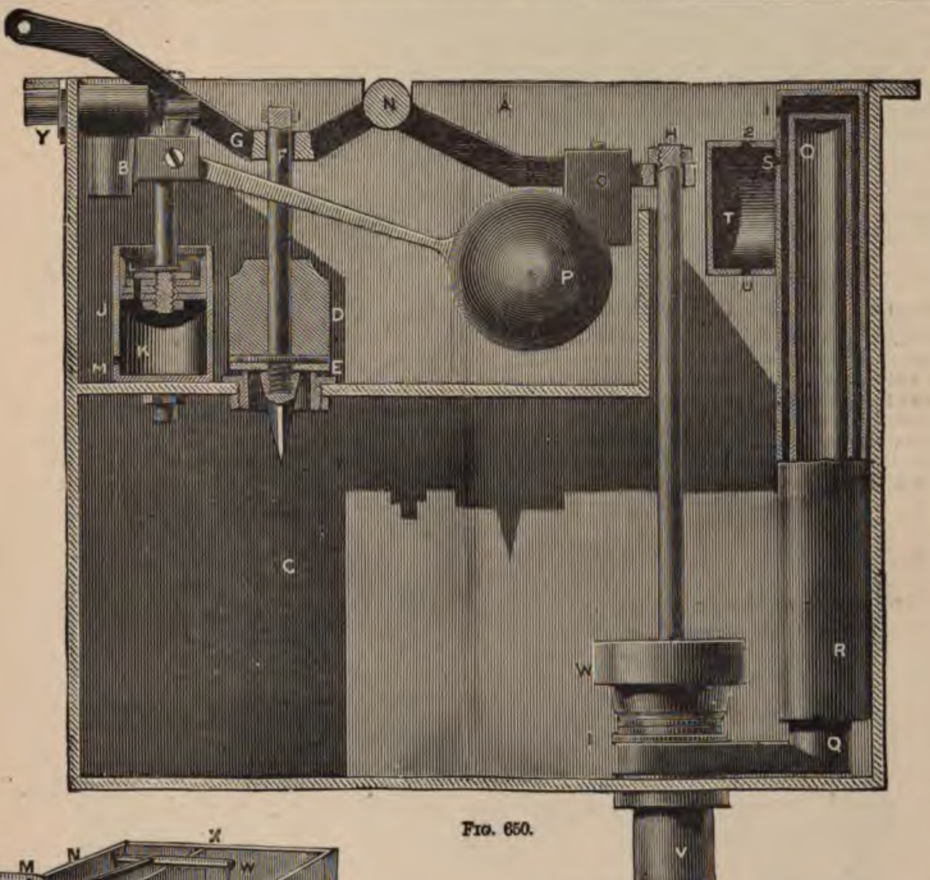


FIG. 650.

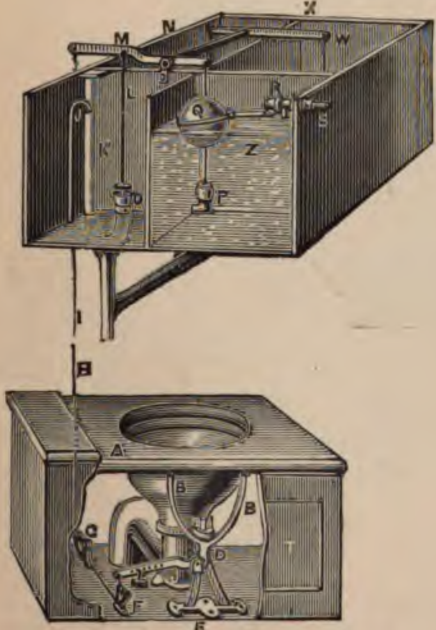


FIG. 651.

very small, it is constantly corroding up, whereas this system obviates this difficulty, and also prevents the air rushing down the down pipe with the water, which, to say the least, is not at all agreeable to the ears.

Seat-aotion, Waste-preventing Valve Cisterns.

Such a closet and valve arrangement will be found illustrated in Fig. 651. The various parts are as follows.

The seat of the closet represented in Fig. 651, has two horns or standards, B B, which are connected to the lever J; this lever is weighted at F, and by wire connected to the cranks, which communicate with the cistern-lever at M. It will be seen that if any person sits upon the seat, the lever M is immediately set in motion, and so first closes the valve O, by reason of this end of the lever dropping; but as the other end of the lever rises, after a little distance through lost motion, so it brings up the valve P, and allows the water to fill up the compartment K, and so be ready by the time the seat is allowed to rise, freeing the lever M to rise likewise, and so opens the valve O, which flushes the closet. My readers will say that this is only single action; but by having the lever M connected to another, as at W X, the end N will fall with the end M, and first close a valve covering a pipe leading from either the first compartment L, or from another into W, when

the valve on the N end of the lever is closed, so as to prevent the water entering from Z to W. The valve in the bottom of the compartment W allows the water to flush the W.C., which must take place when the seat is sat upon, and the valve O opens on the rising of the person from the closet-seat. For this action see also Fig. 652. So that this can be arranged for either single or double action. I may also remind my readers that any of the double action closet valves before described may be adapted to seat-action closets. Perhaps the better title for these valves would be double-flush action valves.

Tylor's After-flush, and Double Valve Action Service Box Waste Preventer. [Fig. 652]. Patented.

This is a double-valve service box especially designed to give the after-flush so necessary to all closets requiring the water to be left in the basin after the handle is dropped. It will be seen that the box B is the inlet or service box, wherein the ball valve works, and that D is the valve which governs the waterway L to K, which supplies the outlet box O. It will also be evident that there is a third chamber or box, P, which is the after-flush box. This has pipe M. In box O the outlet valve F is also fixed. S is the overflow. A the inlet.

The action is as follows:—Suppose the box B to be full of water,—pull down the lever W; this first closes the valves, D and E. After which continue (through lost motion) the pull, say 1in.; through lost motion during this time you are not interfering with any of the valves; but by so continuing the pull you lift the valve H; this fills the box P. Also lift the valve F, which allows the contents of the box O to flush the closet. Keep the pull still, and no more water can be obtained; but release the pull, and the weight N on lever first closes the valve F, then the valve H, stopping off the communication between the boxes B, P, O, M, and as soon as this is done it opens the after-flush valve E, which gives the contents of the box P to the closet. When E opens, D opens also, and fills the box O.

Guest and Chrime's Cisterns.

This waste-preventer was, and is, one of the first in the market, and of the double-chambered kind.

Fig. 653 is the waste preventing cistern or box, suitable for any W.C., &c., without cover. Fig. 654 is a section of same, showing the valves, also ball, &c. Figs. 655, 656, 657, are elevation section and plan showing

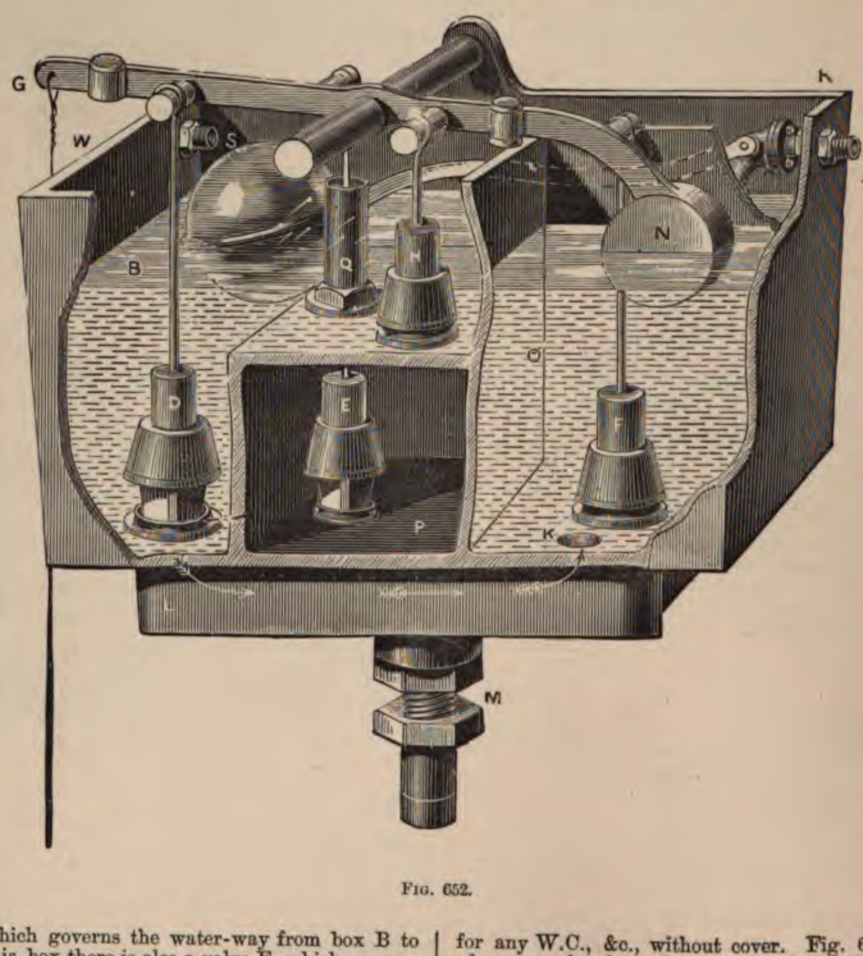


Fig. 652.

a valve H, which governs the water-way from box B to box P. In this box there is also a valve E, which governs the communication pipe between the box P and the down

other arrangements of the cisterns, with trapping box for pan or valve closet, Fig. 655 having a lid complete.

These cisterns are in action the same as that of Stone's, and are too well known to require further description.

Fig. 653.

Fig. 655.

Fig. 654.

Fig. 656

Fig. 657.

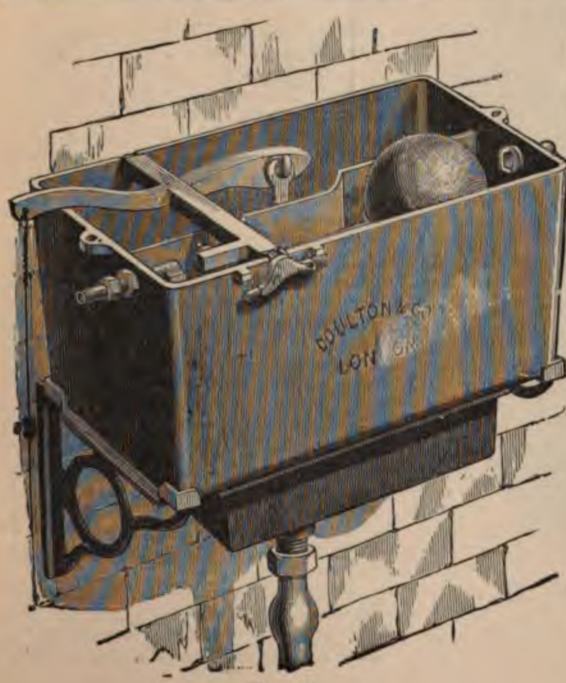


Fig. 658.

Doulton's Waste Preventers.

Fig. 658—This cistern is of the double-valve kind, and is on the after-flush principle. These cistern boxes are made of good stout material, and are, as is well known, next to impossible to put out of order, when once fixed in their places.

Fig. 659.

Fig. 660.

This firm also supplies the brackets for fixing the waste-preventer [see Figs. 659 and 660]. They are made to fix or screw against woodwork or to be let into the brick work. Fig. 661 is the ordinary chain and pull. Fig. 662 is the

cover, which is fixed with four screws to keep the lever down on its bearings.

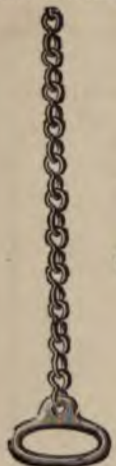


Fig. 661.

Fig. 662

Midway Cisterns, or Waste Checking Boxes without Valves.

[Fig. 663.]

This service-box is for fixing in closets or other places out of the way. It requires no ball-valve. By referring to the figure, it can be seen that it is supplied at the top at A, B answering as an air pipe. The outlet is shown by the front being cut away. The action is as follows:—Having all the pipes connected; A to the large supply cistern; B, or air pipe carried above same; the union at bottom of box to pipe to W.C. valve or cock. Now let the valve at W.C. be shut, and the water allowed to flow through A into box, the same filled up, including pipe to W.C. valve or cock. Open the W.C. valve, and the water will run continually, but as the pipe from bottom of box is, say 1in., and the inlet A regulated to say $\frac{1}{8}$in., the inlet cannot supply the outlet only at a very limited degree, and as you contract this pipe A so is the waste prevented accordingly. One thing in favour of the apparatus is that there is no ball-cock to overflow or get out of order.

Many years ago I made a lot of these boxes to fix between some 9-inch joists, and they are, in fact, the shape of that shown at Fig. 664. These boxes will continue to work, and last as long as the material of which they are made, and if they are properly regulated there is nothing better required. Many will say that they are not absolute water waste-preventers. This is quite true, but they are good enough for checking waste.

Suppose the closet valve below the seat to let by, say, at the rate of half-a-gallon per minute, and that the supply to this check box is adjusted to supply at this rate, it is certain that a person using the closet cannot get a flush, and this would at once tell them that something must be done to get sufficient water to keep the closet clean.

There is another advantage in using this box arrangement, and that is that several closets may be supplied through one box, a most desirable thing under certain circumstances.

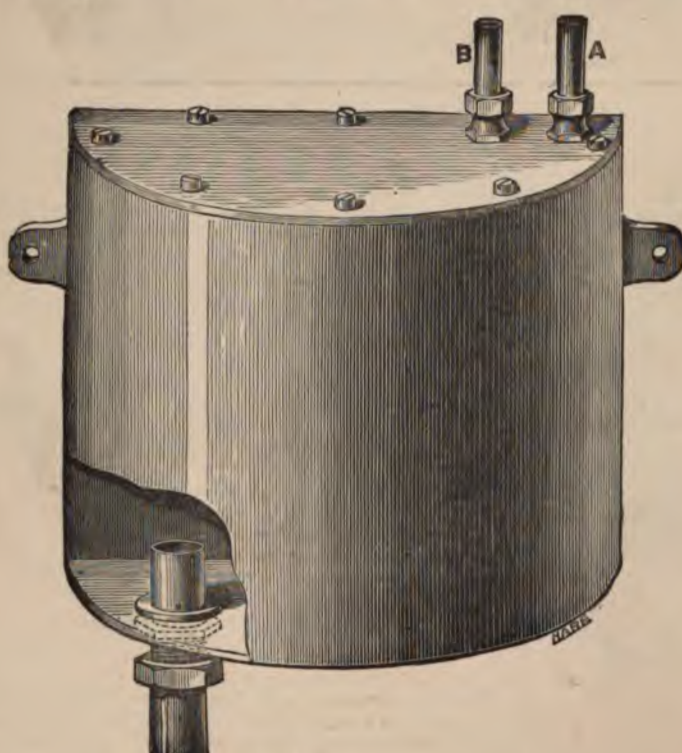


Fig. 663.

Waste-Preventer Cisterns and Boxes Fixed below Closet Seats.

The check-box, Fig. 663, may with advantage be fixed below the closet seat, which may be fixed directly above. You may say that any other cistern may also be fixed; quite so, but it is not at all pleasant to have your wits frightened out of you when quietly taking your ease upon the seat of a closet by the sudden clang of a water waste-preventer. There is another reason why I do not like to fix a waste-preventing cistern under a closet seat, and that is, I do not like to hear the water dribbling into the cistern—it, to say the least, fidgets one.

Your answer to this may be that you can muffle the ball-valve out by placing a short length of rubber tubing from the spout of the ball-valve to the bottom of the cistern, so as to convey the water into the cistern quietly. This is all very well, but it is not all plumbers that will take the trouble, even though they may know what a muffle is, which hundreds do not.

There is another reason why water waste-preventing cisterns should not be fixed under a closet seat—that is, that the water keeps the place damp,

and rusts the iron work of the closet and valves, to say nothing about the damp arising and causing the seat to split and warp about; and I say, that taking all the surrounding circumstances into consideration, the waste-preventing cistern should not be fixed below a closet seat.

Waste Checking Boxes for Cisterns.

Fig. 664.—This box is upon the same principle as Fig. 663, the difference being that it is for fixing in iron or slate cisterns, and has a small hole in the side for filling, much about the same as Fig. 594, the difference being that Fig. 594 has a valve B fixed in same for shutting off the water to W.C., and Fig. 664 may have the valve anywhere in the length of down pipe to W.C., or fixed under seat of W.C.

Fig. 665.—This service-box is in action similar to the last explained, but for soldering over the down pipe to W.C. or, in fact, to a sink, &c. You see that it has the inlet at the right-handed end. Put an air-hole on the top for air-pipe.

Common's High Pressure Service Box.

Fig. 666 is a section elevation of Common's high pressure service-box. D is the box, which may be of lead or other material; A is the supply valve to same; B is the outlet valve, worked by the spindle I. It must be stated that although both these valves are worked by this one spindle, the one can be opened and the other closed at the same time, and that the two cannot be open at one and the same time. This being the case, say the inlet valve A is open to the main, and the water in main under pressure, the water is sent through A and along the pipe R to the box D; but as there is no escape for the air it becomes compressed, and the water kept down, as shown, in the box. But shut off the inlet pipe by pulling up the lever G, then by continuing the pull open the outlet valve B, and the compressed air within top of box B will send out the water to flush the closet, and with equal force to that in the main. F is a small pipe fitted to drain the pipes empty. This plainly shows that pneumatics and hydrostatics combined are useful agents even in waste preventers. [Also see Fig. 564.]

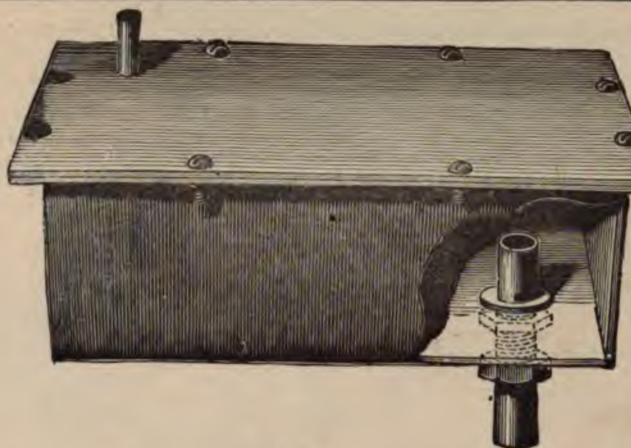


FIG. 664.

FIG. 665.

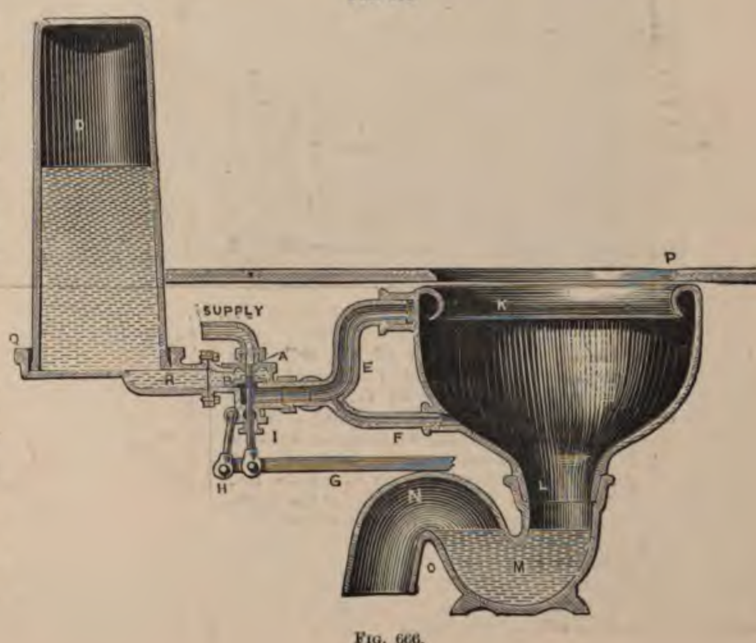


FIG. 666.

The Plunger and Siphon Waste Preventer.

[Patent 1579, A.D. 1873.]

[Fig. 667.]—This is a waste-preventer constructed after the principle of the plunge pump, coupled with a box and siphon. A is the box of lead or other metal; B is a 4-in. brass or other tube (a piece of 4in. soil pipe will answer the purpose very well) soldered in top of box: D is a plunger made to fit within tube B; this may be of brass tube or otherwise, with the end stopped up; F is the ordinary spring-board, or any other contrivance suitable for the work; H, the air pipe not more than, say, $\frac{1}{4}$in. in diameter; K, the siphon, which is taken to within 1in. of the bottom of the box A; L is a $\frac{1}{8}$in. hole for the inlet. In some cases I make the latter to work with an open box, with the piston, D, having a valve in bottom opening upwards, the piston to pull up to start the siphon; the siphon then to be fixed as per dotted lines, and the bucket or plunger as the ordinary pump bucket, as at PUMP BUCKET, Fig. 667, may be employed.

The action is as follows:—The box being full of water, by pulling the lever F, it plunges the water out of the tube into box, and as this will not expand it must go somewhere. So it does; it rushes up the siphon pipe K; when the water in this pipe is past the level or top of cistern, or the throat of siphon, the siphon comes into play (of course when the water in long leg of siphon is below the level of water in box), and empties the box by reason of the air-pipe; and the inlet being too small to keep the siphon supplied, the siphon is broken and ceases to run.

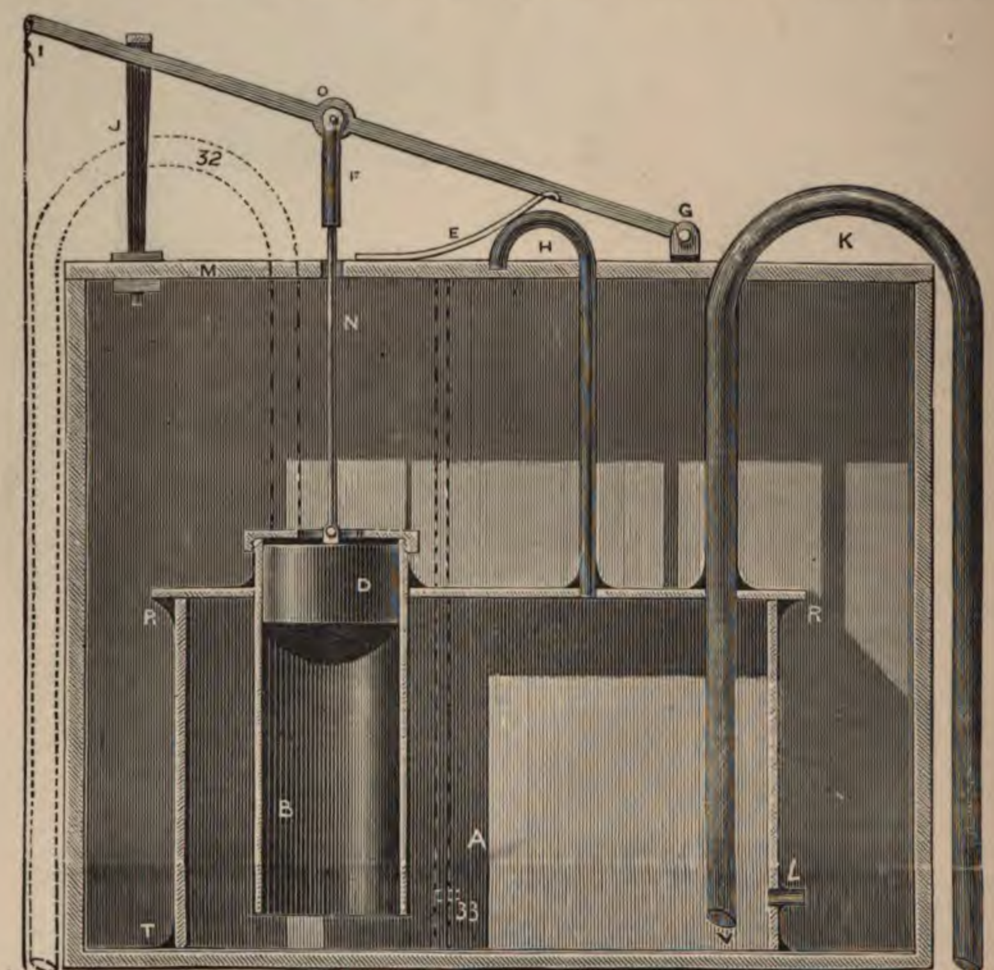


Fig. 667.

PUMP

BUCKET.

Next the box fills with water ready for another operation. I have made this plunger and service-box to work many ways, with and without valves, sometimes by lowering or raising the siphon above or below the level of the water, or by the application of a brick dropped into the water; in fact, when I look back upon the different modes of siphon work, I see a sameness which would only occupy your time in waste if I go farther with this subject.

Trough or Shoot Waste Preventers.

Fig. 668 illustrates a waste preventer made by Warner's people, and is made to work as shown with a kind of trough or shoot having a circular bottom, wherein the ball floats. It will be seen that by pulling the handle the contents of the circular shoot will be nearly emptied into the square cistern, where it runs away down the down pipe, but sufficient water is left in the bottom of the circular trough to float the ball, which on the handle being allowed to rise falls lower into the box, and with it the ball, when the trough will be refilled with water.

FIG. 668.

Valveless Waste Preventers.

There are scores of this class of waste preventers in the market. Some are made to work by dipping one end of a trough into the water, and then pulling it up full of water and tipping it over a partition leading to the down pipe of a W.C.; in fact it is nothing more than the adaptation of the well-known Hindostan or zantu gutters described by Ewbank. Sometimes these valveless waste preventers are made to work by simply fitting and hinging a flat plate of metal to the lower or other part of a cistern, and in such a manner that by pulling it upwards or otherwise, it will cause the water to flow forward and over a kind of partition, and into a compartment, and down the down pipe to the closet, and in fact scores of other ways.

Screw and Fan-action Waste Preventer

Sometimes these waste preventers are made to work as follows: Above the valve is fitted a very sharp pitch screw, which on being pulled up, the one part is allowed to run down; the descending part of the screw is retarded by means of a fan which beats the water, or it will work equally well in the atmosphere, like the fan of a striking clock.

Siphons, Compound Acting as Valves.

No doubt you have been troubled with air-bound water pipes. The following will give you an idea of what is meant. A cistern is fixed 10ft. high; a ½in. or ¾in. pipe is taken out at the end; it runs along a wall; during this length there are one or two traps; it then goes down five or six feet, when it rises again, say 4ft., and then goes in a horizontal direction to a draw off cock. First charge the whole of the pipes and cistern; then let the cistern empty; again fill the cistern, and you will find that the water will not run through the pipe until the air is pumped or otherwise removed from between the traps.

This phenomenon may be reasoned out as follows: Suppose the water in the trap at F G, Fig. 669, to be 6ft. and

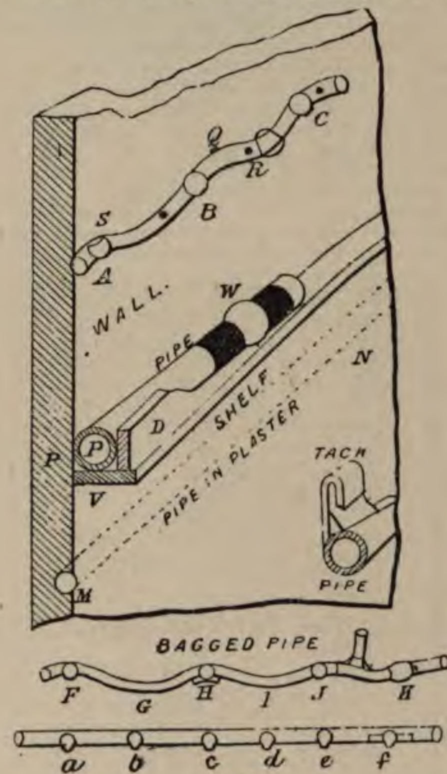


FIG. 669.

that at H I to be also 6ft., it is evident that there will be a 6ft. column of water to remove, and in order to do so the water within the cistern and short stump of pipe between J and H must exceed this 6ft. in order to force the confined air out of the pipe.

Pipe Fixing on Walls

Oftentimes can be seen old leaden pipes fixed along walls having the appearance of that shown at A, B, R; and F, G, H, Fig. 669. The cause of the pipe sagging is for the want of sufficient wall hooks to support the lead. See the pipe F G H I J, Fig. 669, and then examine *a*, *b*, *c*, *d*, *e*, etc.; this latter line of pipe has about twice the quantity of hooks, and thus better support is given.

Pipes in Box Casing.

Sometimes, especially for hot water pipes, the lead pipes are fixed on a shelf, or in a casing as shown at P, D, W, Fig. 669. Here the heat is retained, also a fall can be given, so that the pipe can be made to drain itself empty, and a further advantage is, that it is protected against frost, etc. Sometimes the lead pipe is partially embedded within the plaster, which prevents this sagging.

The Air Waste Preventer (and) Automatic Flushing Tank.

Patent 1,579, A.D. 1873. This is illustrated at Fig. 670. A, the large cistern; K, the 7lb. lead service-box, soldered down on lead cistern, having an aperture B, to supply-box. On this box is also an air-pipe I, wherein works the rod M. C is the inverted cap or cup, which fits nothing, but is loose in water. This cup or cap covers the end of the outlet pipe D, thus regulating the action of this curiosity. This pipe also goes down and dips into the cup G; this dip should also be that of C, viz., the same depth. Outside this cup is the tube H, connected to the pipe D, and continued to the down pipe N, which also communicates with the siphon L, and this is the discharge pipe also. What is the action of this? will be the next question, and it is a question worthy of the greatest philosopher's notice. Let the cistern A be full of water, and the box-hole B clear; the water will run through same and under the first cap or cup C, up under same, and over the end of the stand or outlet pipe D. It will also run down the inside of same and into the cup G overflow same, and down the outlet tube H and N, into the siphon L, and discharge itself at O. This being the case, you may say—"How do you make this out to be a waste-preventer, as it continually runs to waste?" Lift up the cup C above the mouth of the stand-pipe D, and let it drop again. The service-box now fills. Why? Because you have lifted the cap C, and by so doing you have admitted air; you have dropped it down again and thus imprisoned air in the pipe D, and by lowering the tube, cup, or cap C, you have compressed this air, which will stand against its equal column of water in the external atmosphere. Pull up the cap C, and the water column is no longer balanced; but the extra weight in box drives all before it and gives a good flush to W.C. Let the cup down as soon as you like, the box will empty and is ready for another operation.

It should be here remarked that this apparatus is very sensitive to bad workmanship, and also to bad proportions, for if the pipes are not properly balanced the thing is useless.

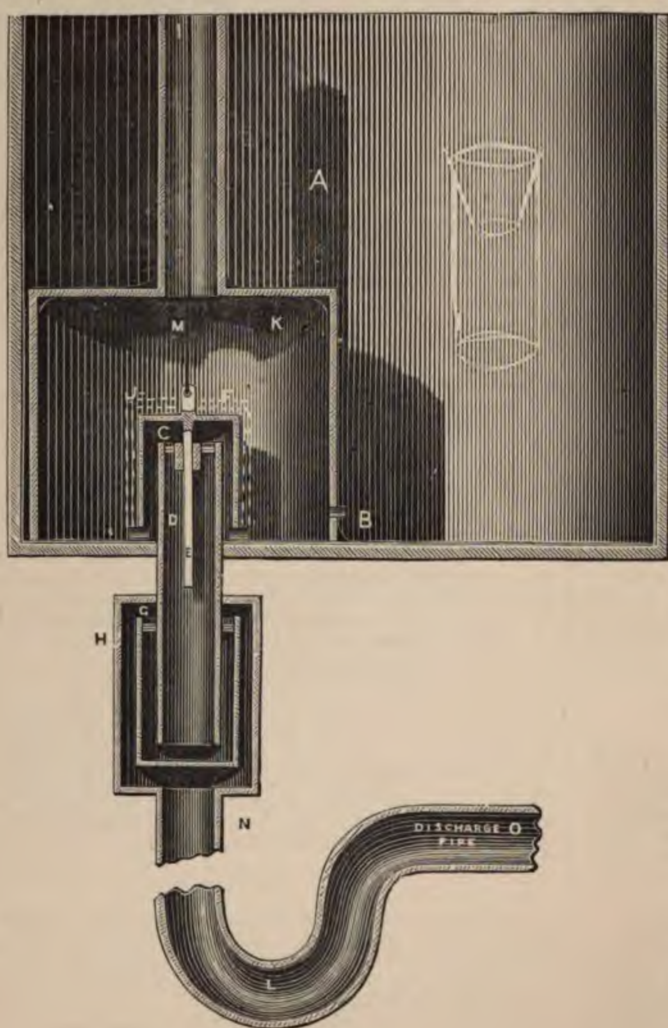


Fig. 670.

You see that the apparatus will act, and as long as you hold up the cup C the water will run away. But this cannot strictly be considered a water waste-preventer. No matter how small the hole B may be, it is a hole, and there is the fact that water will continually run away if you keep up the cap. The same applies to Figs. 594, 595, 664, 665, &c., which I should have noted at the time. Now let me show you how to convert the Fig. 670 into an absolute water waste-preventer. Notice the outside cap J F, in dotted line; instead of the rod M being connected to the cup C, connect the rod to the outer cup, J F, and let the inner cup fit within, say, one-eighth of an inch, the outer to allow for corrosion, and as that described at Fig. 638. Now let the box be full of water, and pull up the cap J F; you will find it take up the inner one, and that the inner one will slowly descend again, no matter how long you may hold up the outer cup. The inner cup has shut off the water again, and is ready for another operation.

This principle of waste preventer also works very well when the water is only up to within an inch of the lip of the stand pipe C, and may then be used without the outer box B K M. I should also remark that if the trapping dip pipe D G be used without the bottom siphon, it will give automatic flushings, which may be regulated to work once per day or week, &c., but in this case the lower lip of the pipe D must only dip into about ½in. of water, when the water trickling down will drive out all the air, and so create a vacuum in the pipe D, which on being created the water again loses its equilibrium, and at that instant the standing column in pipe D becomes a little heavier than that above, and so begins to fall, which will empty the tank or box B, at desired intervals. For this automatic flushing purpose it will be quite as well to open the top of the pipe D C, and fix a receiving cone as shown by the white lined figure on the right of the cistern, so that the water will drop clearly through the pipe D without touching its sides, though this is not absolutely necessary, as the spindle E and bridge partially answer this purpose.

Winn's Waste Preventer.

This is illustrated at Fig. 671, and will be easily understood after reading the description of Fig. 670. In this waste-preventer the loose cap is shown fixed over the end of the siphon; it is clear and well known that the confined air contained between two traps will resist the water above, equal, and in proportion to the amount of water seal given in the bottom trap, which will be well understood by plumbers who have experienced the difficulty of getting water to run through pipes which have air pockets. The above waste-preventer is unquestionably a lasting one, as there are no valves to wear out or to get out of order.

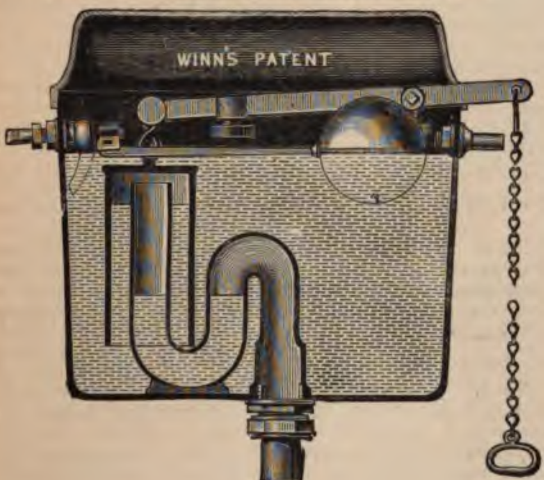


FIG. 671.

Waste Preventers Considered.

My experience is that waste-preventers are very good things in their place, but to enforce the application of the same to every house is not at all in accordance with my view of sanitary matters—in fact, is foolery and a nuisance. Fancy a first-class house being fitted up with unsightly and often clamorous iron pests, often got up by such as find their way from water companies' trench or ground workmen to inspectorships. These people will not hesitate for one moment to say that you will have to use So-and-so's; another will say, "This may be used, but this we recommend." I have noticed that plumbers invariably take the recommended article, which is nearly always a trumpery box with some fancy name, and it is invariably an apparatus which you can trace to some company's servant, or one that they are interested in; and it is for this reason that I have spoken of waste-preventers at a much greater length than I otherwise should have done, knowing the necessity of being able to select one suitable for each or any particular class of work.

"Cistern Overflows when Branched into the Closet Supply Pipe."

A cistern overflow is often branched into the down or supply-pipe to the closet, and answers as an air-pipe. That, if properly trapped below the closet, is good enough for any *closet-work*, excepting that in very severe weather it is apt to become frozen, and that this trap to some extent interferes with the flow of water at the first moment of supply, by reason of the confined air between the trap and the water-plug after the valve has been lifted. You may have noticed this in some closets by the manner of the water supply spluttering on its first appearance into the basin.

Allowing the true value to these exceptions, the best plan is to arrange the overflow so that it should fall over or into a well-supplied trap, or into the open air; but when neither of the latter methods are practicable, its mouth or inlet may be covered with a valve, and opened by the rising of a float having a rod, or the float may be fixed directly over the mouth of the overflow pipe. It is quite as well when adopting the float arrangement, if the bottom valve is fitted with an inverted cup to cover the top of the overflow-pipe, and so form a *trap* when the water is within two or three inches of this pipe, which compensates for the valve being partially open as the water rises in the cistern.

54, 55, 56 and 57, Fig. 628, illustrate the float arrangement as fixed on some cisterns that I have lately lined. 77, 78, 79, 80, 81, 82, etc., in the same figures illustrate a hydrostatic supply-valve for cisterns.

Ball-less Supply Cistern Valves.

[*See* 84, Fig. 628.]

This valve entirely dispenses with the ball-valve, and is fixed to work *in the bottom* of the cistern, in lieu of the top. This will, to some of my readers, be quite a new feature—viz., to fix the inlet valve in the bottom of the cistern, and cause it to work without a float or ball, or this valve may be fixed outside the cistern, and work with the same advantage.

[For a further account of Valves, see Water Supply, next volume.]

REGULATIONS FOR WATER PIPES AND FITTINGS, MADE UNDER THE METROPOLIS WATER ACT, 1871, AND SANCTIONED BY THE BOARD OF TRADE, LONDON.*

NOTICE.—The Metropolis is defined and sanctioned by the Board of Trade Management Act, 1855.

Place of Communication Pipe.

No. 1. No "communication-pipe" for the conveyance of water from the waterworks of the Company into any premises shall hereafter be laid until after the point or place at which such "communication-pipe" is proposed to be brought into such premises shall have had the approval of the Company.

Comment.—The communication pipe is the main pipe from the street main to your cistern or draw off tap.

From this Clause 1, it is clear that you must be very particular about the selection of your place, viz., it must not run through a drain, cesspit, or such like places, but through such places that you can at all times get at it. If it runs under concrete floors, run your pipes through drain pipes, so that you can cut the pipe and draw it out if required for repairs, unless you can vouch for it being well out of the way of the frost, and that your pipe will stand for a century or two. This pipe should not be covered up without being first tested with water.

Weight of Lead Pipes.

No. 2. No lead pipe shall hereafter be laid or fixed in or about any premises for the conveyance of or in connection with the water supplied by the Company (except when and as otherwise authorised by these regulations, or by the Company), unless the same shall be of equal thickness throughout, and of at least the following weight:—

Internal Diameter of Pipe in inches.	Weight of Pipe in lbs. per Lineal Yard.
$\frac{3}{8}$-inch diameter	5 lbs. per lineal yard.
$\frac{5}{8}$ " "	6 " "
$\frac{3}{4}$ " "	$7\frac{1}{2}$ " "
$\frac{1}{2}$ " "	9 " "
1 " "	12 " "
$1\frac{1}{4}$ " "	16 " "

Interior Pipes.

No. 3. Every pipe hereafter laid or fixed in the interior of any dwelling-house for the conveyance of, or in connection with, the water of the Company, must, unless with the consent of the Company, if in contact with the ground, be of lead, but may otherwise be of lead, copper, or wrought iron, at the option of the consumer.

Comment.—Iron is the worst material for water pipes which are required to stand; besides, this material soon becomes blocked with rust, &c., and unless there be a very high pressure, the stream soon becomes very poor.

Not more than one Communication-Pipe to each House.

No. 4. No house shall, unless with the permission of the Company in writing, be hereafter fitted with more than one "communication-pipe."

Every House, with certain exceptions, to have its own Communication-Pipe.

No. 5. Every house supplied with water by the Company (except in cases of stand pipes) shall have its own separate "communication-pipe." Provided that, as far as is consistent with the special Acts of the Company, in the case of a group or a block of houses, the water-rates of which are paid by one owner, the said owner may, at his option, have one sufficient "communication-pipe" for such group or block.

Comment.—You can for a few pence obtain any of the water Acts of Parliament at Messrs. Spottiswoode & Co's., 87, Chancery Lane, London. [See pages 273 to 290.]

No house to have connection with Fittings of adjoining house.

No. 6. No house supplied with water by the Company shall have connection with the pipes or other fittings of any other premises, except in the case of groups or blocks of houses, referred to in the preceding regulation. [See Clause LXIX., Act 1847.]

Connection to be by Ferrule or Stop-cock.

No. 7. The connection of every "communication-pipe" with any pipe of the Company shall hereafter be made by means of a sound and suitable brass screwed ferrule or stop-cock with union, and such ferrule or stop-cock shall be so made as to have a clear area of waterway equal to that of a half-inch pipe. The connection of every "communication-pipe" with the pipes of the Company shall be made by the Company's workmen, and the Company shall be paid in advance the reasonable costs and charges of and incident to the making of such connection. [See No. 45, Clause XLIX., page 275.]

Comment.—Some Companies use their own kind of ferrule. The West Middlesex have their engineer's ferrule, and the Grand Junction have their own, whilst the East London, Lambeth, New River, &c., use the ordinary bent ferrule with union. The New River Company are very particular about the brass work, and will have it all tested and stamped with the N. R. stamp before they will lay on the water. For my part, I think it an excellent idea, but cannot say that they have the law upon their side to enforce such an act, should they meet with a man willing to fight it out, for all that is required by the Act is that the fittings shall be sound and suitable for the purpose.

Material and Joints of External Pipes.

No. 8. Every "communication-pipe" and every pipe external to the house and through the external walls thereof, hereafter respectively laid or fixed in connection with the water of the Company, shall be of lead, and every joint thereof shall be of the kind called "plumbing" or "wiped" joint.

No Pipe to be laid through Drains, &c.

No. 9. No pipe shall be used for the conveyance of, or in connection with, water supplied by the Company, which is laid or fixed through, in, or into any drain, ashpit, sink, or "manure hole," or through, in, or into any place where

For the power of the Board of Trade to make provisions, see Clause XV., Act 1852, page 278, and No. 71, page 279; also see No. 102, page 283, and No. 104, page 284.

the water conveyed through such pipe may be liable to become fouled, except where such drain, ashpit, sink or "manure hole," or other such place, shall be in the unavoidable course of such pipe, and then in every such case such pipe shall be passed through an exterior cast-iron pipe or jacket, of sufficient length and strength, and of such construction as to afford due protection to the "water-pipe."

Depth of Pipes under Ground.

No. 10. Every pipe hereafter laid for the conveyance of, or in connection with, water supplied by the Company, shall, when laid in open ground, be laid at least 2 feet 6 inches below the surface, and shall in every exposed situation be protected against the effects of frost.

No connection with Rain-Water Receptacle.

No. 11. No pipe for the conveyance of, or in connection with, water supplied by the Company, shall communicate with any cistern, butt, or other receptacle used or intended to be used for rainwater.

Stop-Valve.

No. 12. Every "communication-pipe" for the conveyance of water to be supplied by the Company into any premises shall have, at or near its point of entrance into such premises, and if desired by the consumer within such premises, a sound and suitable stop-valve of the screw-down kind, with an area of waterway not less than that of a half-inch pipe, and not greater than that of the "communication-pipe," the size of the valve within these limits being at the option of the consumer. [See Fig. 250, &c.]

If placed in the ground such "stop-valve" shall be protected by a proper cover and "guard-box."

COMMENT.—If you fix the stop-cock inside the coal-hole, don't fix it as thousands are, viz., in such a position that when the hole is full of coals you cannot get at the cock to turn it. There appears to be some mistake about the class of stop-cock. I contend that the best class of cock for the Company is a good gland ground-in straight-way gunmetal cock, *with unions each end.* Think how much friction there is in the ordinary screw down cock. This must check the water in the mains.

Character of Cisterns and Ball Taps.

No. 13. Every cistern used in connection with the water supplied by the Company shall be made and at all times maintained water-tight, and be properly covered and placed in such a position that it may be inspected and cleansed. Every such existing cistern, if not already provided with an efficient "ball tap," and every such future cistern, shall be provided with a sound and suitable "ball-tap" of the valve kind for the inlet of water.

COMMENT.—Ball Cocks.—The best are the cheapest in the end. The valve should be allowed to open the diameter of the seating, in order that a small stone, &c., may be allowed to pass the seating without becoming jambed, which spoils the seating of the valve. My experience is that valves opening horizontally are better than those working vertically, for in the former little bits of solid matter can drop direct from the seating, whilst in valves with vertical seatings the solid substance will drop on the valve, and is held there by the sides of the outlet.

Waste Pipes to be removed or converted into Warning Pipes.

No. 14. *No overflow or waste pipe other than a "warning pipe" shall be attached to any cistern supplied with water by the Company, and every such overflow or "waste pipe" existing at the time when these regulations come into operation shall be removed, or at the option of the consumer shall be converted into an efficient "warning pipe" within two calendar months next after the Company shall have given the occupier of, or left at the premises in which such cistern is situate, a notice in writing requiring such alteration to be made.*

COMMENT.—This is rather a good thing, inasmuch as thousands of wastes are being cut off which have been fixed into the drains, soil pipes and such like, which, to say the least, is not good, from a sanitary point of view. Many plumbers run away with the erroneous idea that they must stop up the end of the waste pipe and put in a new warning pipe, but this is not so; simply cut it off from the drain or other objectional place, and convert this same waste pipe into your overflow pipe to discharge into the open air. This waste pipe may be rendered useful for a cleansing pipe for emptying the cistern, and may be fixed to discharge into an open head, &c., but if this is the case you will soon have your water man on to you, if he cannot get to see the open end. In such cases you must stop up the end of your standing waste and provide a fresh overflow pipe.

Arrangement of Warning-pipes.

No. 15. Every "warning-pipe" shall be placed in such a situation as will admit of the discharge of the water from such warning-pipe being readily ascertained by the officers of the Company. And the position of such "warning-pipe" shall not be changed without previous notice to and approval by the Company.

COMMENT.—Notice, the warning-pipe is taken from the old warning-pipes fixed from within 1in. of the top of cistern, and brought to the handle of the pump as a tell-tale when the man has pumped sufficient, but the warning-pipe in the case in point is of far greater importance. It is here as an overflow pipe, and instead of being a small ½in. pipe, it should be at least sixteen times the size, if the cistern is only supplied with a ½in. main; and in proportion to the size and pressure of the incoming water, so should be the size of the warning pipe. N.B.—I spoke of warning-pipe being taken from the old warning-pipe, as though it was not used for pumps now, the reason being, that I have fixed plenty; but being in London so long, one fancies the good old country work has all died out, but happily it has not.

Buried Cisterns prohibited.

No. 16. No cistern buried or excavated in the ground shall be used for the storage or reception of water supplied by the Company, unless the use of such cistern shall be allowed in writing by the Company.

Butts prohibited.

No. 17. *No wooden receptacle without a proper metallic lining shall be hereafter brought into use for the storage of any water supplied by the Company.*

Ordinary Draw-Tap.

No. 18. No draw-tap shall in future be fixed unless the same shall be sound and suitable and of the "screw down" kind.

COMMENT.—This is a wrong idea, for the simple reason that the screw down cocks are only useful for high pressure work, or for places where there is at least. 20ft. head of water; if they are used for low pressure work, you cannot get them to run fast enough. There being so many turns for the water to pass, to say nothing about the number of turns required to open and close them, half the time people will not trouble to close them, whilst, on the other hand,

with the ground in cock there is no bother. If valves must be used, why not use for *low pressure work* spring-valves, or else push-valves with cup leathers.

Draw-taps in connection with Stand-pipes.

No. 19. Every "draw-tap" in connection with any "stand pipe" or other apparatus outside any dwelling-house in a court or other public place, to supply any group or number of such dwelling-houses, shall be sound and suitable, and of the "waste-preventer" kind, and be protected as far as possible from injury by frost, theft, or mischief.

Comment.—I should here remark that you must go about this job very cautiously, for there are a number of waste-preventer cocks in the market, some very good, whilst others are useless. The best plan is to apply to each Company for what they allow, and make yourself right with them first. You see the clause states a waste-preventer cock, but there are double valve stand posts in the market which answer every purpose. They are made as shown at Fig. 648 and simply work like the double valve cisterns before described.

Boilers, Waterclosets, and Urinals to have Cisterns.

No. 20. Every boiler, urinal, and water-closet, in which water supplied by the Company is used (other than water-closets in which hand-flushing is employed), shall, within three months after these regulations come into operation, be served only through a cistern, or service-box, and without a stool-cock, and there shall be no direct communication from the pipes of the Company to any boiler, urinal, or water-closet.

Watercloset Apparatus.

No. 21. Every "watercloset-cistern" or watercloset service-box hereafter fitted or fixed in which water supplied by the Company is to be used, shall have an efficient waste-preventing apparatus, so constructed as not to be capable of discharging more than two gallons of water at each flush.

Comment.—Here it simply states that the waste-preventing apparatus shall be efficient and must not be capable of discharging more than two gallons at each flush (which is two gallons too small). From this it is evident that the Water Company's power is limited to the words efficient, and to the quantity only. They should also have determined the size of outlet valve seating, which should be at least 2in., and with nut and lining to match. It does not say anything about the size of the cistern, nor size of service-box, but most likely the person that drew up this rule did not know what a service-box was. One thing is certain, it is not a cistern, as some people are inclined to think it is.

Urinal Cistern Apparatus.

No. 22. Every urinal-cistern in which water supplied by the Company is used, other than public urinal-cisterns, or cisterns having attached to them a self-closing apparatus, shall have an efficient "waste-preventing" apparatus, so constructed as not to be capable of discharging more than one gallon of water at each flush.

Watercloset Down-pipes.

No. 23. Every "down-pipe" hereafter fixed for the discharge of water into the pan or basin of any watercloset shall have an internal diameter of not less than one inch and a quarter, and if of lead, shall weigh not less than nne pounds to every lineal yard.

Comment.—This is not good, because the height has all to do with the size of this pipe. For instance, the closet may be a very low one, not 6ft. high; here the cistern could not be fixed high enough for good flushing. See size of pipes under head, Proving Closet Flushing, page 226, where it says that the head (lowest) of water should be 5ft., the head being the fall of water from cistern to arm of basin, which in a 6ft. closet could not be more than 3ft. 2in.; here a 1½in. or 2in. pipe is required.

Pipes supplying Waterclosets to communicate with Cistern only.

No. 24. No pipe by which water is supplied by the Company to any "watercloset" shall communicate with any part of such watercloset, or with any apparatus connected therewith, except the service cistern thereof.

Comment.—The effect of this clause is this, that you must not attach the communication-pipe to a valve, say under the seat, &c., but the water must first flow into a cistern of some kind, whether it is a large leaden one or a small waste preventing cistern: it's all the same to the water company. One thing is certain, that the water should flow into a large cistern, to keep up the supply in case the water should be turned off for repairs, &c.

Bath to be without Overflow Pipe.

No. 25. No bath supplied with water by the Company shall have any overflow "waste-pipe," except it be so arranged as to act as a "warning-pipe."

Bath Apparatus.

No. 26. In every bath hereafter fitted or fixed the outlet shall be distinct from, and unconnected with, the inlet or inlets; and the inlet or inlets must be placed so that the orifice or orifices shall be above the highest water level of the bath. The outlet of every such bath shall be provided with a perfectly water-tight plug, valve, or cock.

Comment.—This is a very good clause so far as the inlets and waste pipe, for nine-tenths of the baths before this Act came in were simply filthy, so far as regards the inlet and waste pipe.

Alteration of Fittings.

No. 27. No alteration shall be made in any fittings, in connection with the supply of water by the Company, without two days' previous notice in writing to the Company.

Comment.—This should go farther and state that the alterations must be drawn on paper and lodged with the Water Company for approval before the work is allowed to proceed. The work should also be inspected by their representative as it progresses, he having power to stop the work should it not be carried out according to the approved drawings and specification.

Waterway of Fittings.

No. 28. Except with the written consent of the consumer, no cock, ferrule, joint, union, valve or other fitting, in the course of any "communication-pipe," shall have a waterway of less area than that of the "communication-pipe," so that the waterway from the water in the district pipe or other supply pipe of the Company up to and through the stop-valve prescribed by Regulation No. 12, shall not in any part be of less area than that of the "communication-pipe" itself, which pipe shall not be of less than a half-inch bore in all its course.

Weight of Lead Pipes having open Ends.

No. 29. All lead "warning pipes" and other lead pipes of which the ends are open, so that such pipes cannot remain charged with water, may be of the following minimum weights, that is to say—

½ inch (internal diameter)	... 3 lbs.	per yard.
¾ " "	... 5	"
1 " "	... 7	"

COMMENT.—So far as regards this it is all right; but as the warning pipe is also an overflow pipe, it certainly should be proportioned to the size of the main pipe, for what would be the use of a half-inch pipe with, say, only one inch head of water to take the overflow from a half inch or three-quarterinch ball valve running full bore under a water head or pressure of perhaps 250ft. I contend that the largest pipe there is not one-quarter large enough for such work, not even for a half-inch main pipe, especially if there be no fall to the overflow pipe. [See No. 73, page 297.]

Definition of "Communication-pipe."

No. 30. In these regulations the term "Communication-pipe" shall mean the pipe which extends from the district pipe or other supply pipe of the Company up to the "stop-valve" prescribed in the regulation No. 12.

Penalties.

No. 31. *Every person who shall wilfully violate, refuse, or neglect to comply with, or shall wilfully do or cause to be done any act, matter, or thing, in contravention of these Regulations, or any part thereof, shall, for every such offence, be liable to a penalty in a sum not exceeding £5.*

COMMENT.—There should be a law on plumbers or others that are found doing scamping work, viz., that they should not be allowed to contract or to do work in the Company's district for twelve months, and if again reported to be disqualified.

Authorised Officer may act for Company.

No. 32. Where under the foregoing regulations any act is required or authorised to be done by the Company, the same may be done on behalf of the Company by an authorised officer or servant of the Company, and where under such regulations any notice is required to be given by the Company, the same shall be sufficiently authenticated if it be signed by an authorised officer or servant of the Company.

Existing Fittings.

No. 33. All existing fittings, which shall be sound and efficient, and are not required to be removed or altered under these Regulations, shall be deemed to be prescribed fittings under the "Metropolis Water Act, 1871."

COMMENT.—This refers to the old fittings of houses where the water has been laid on and in good working order, but when these fittings become defective, then it will be necessary to replace the old fittings with those prescribed, so that in time all houses will have improved fittings. There is no reason why it cannot be done; we have every kind of waste preventer valve, suitable for every situation.

WATERWORKS ACTS FOR SUPPLYING TOWNS WITH WATER.

In this part of my work on practical plumbing, I shall only refer to the different Acts which are useful to the plumber, when working under Water Companies' Rules and such like; for to print all the parts of the Acts would be simply valueless, whilst those parts which concern the plumber will be found of great value when dealing with waterworks people, and, if carefully attended to, will often save much time in seeking that knowledge which is too often kept away from the general public. Of course any of the following Acts may be had by applying to Messrs. Spottiswoode & Co., Queen's Printers, 87, Chancery Lane, London. I shall, therefore, commence at Clause XXXV. of the Act dated 23rd April, 1847. *The Roman numbers refer to the number of the Clause of each Act, and the first numbers are the numbers of the Clauses in this my work for reference, indexing, &c.* SPECIAL ACTS, *means the Act of Parliament obtained for the special governing of each particular Water Company, and each Company has its own Act.*

ANNO DECIMO

VICTORIÆ REGINÆ.

CAP. XVII.

An Act for consolidating in one Act certain Provisions usually contained in Acts authorizing the making of Waterworks for supplying Towns with Water. [23*rd April*, 1847.]

A Constant Supply of Water to be kept for Domestic Purposes at High Pressure.

No. 34. XXXV.—"The Undertakers shall provide and keep in the Pipes to be laid down by them a Supply of pure and wholesome Water, sufficient for the domestic Use of all the Inhabitants of the Town or District within the Limits of the Special Act [this is the Act of the water company under which you may be working: see clause XC., page 277], who, as hereinafter provided, shall be entitled to demand a Supply, and shall be willing to pay Water Rate for the same; and such Supply shall be constantly laid on at such a pressure as will make the Water reach the top Story of the highest Houses within the said Limits, unless it be provided by the Special Act that the Water to be supplied by the Undertakers need not be constantly laid on under Pressure; and the Undertakers shall cause Pipes to be laid down and Water to be brought to every Part of the

Town or District within the Limits of the Special Act whereunto they shall be required by so many Owners or Occupiers of Houses in that Part of the Town or District, as that the aggregate Amount of Water Rate payable by them annually at the Rates specified in the Special Act shall be not less than One Tenth Part of the Expense of providing and laying down such Pipes; provided that no such Requisition shall be binding on the Undertakers unless such Owners or Occupiers shall severally execute an Agreement binding themselves to take such Supply of Water for Three successive Years at least." [See clauses 22 and 23 of the Waterworks Act of 1852, also clauses 28, 29, and 31, of the Waterworks Act, 1871, for the prescribed fittings.]

Penalty for Neglect to lay Pipes for Supply of Water for Domestic Use. Proviso.

No. 35. XXXVI.—"If for Twenty-eight Days after Demand in Writing made to the Undertakers, and Tender made of an agreement signed by such Number of Owners or Occupiers as aforesaid, to take and pay for a Supply of Water for Three Years or more, the Undertakers shall refuse or neglect to lay down Pipes in the Manner hereinbefore directed, and to provide such Supply of Water as aforesaid, or as provided by the Special Act, they shall forfeit to each of such Owners and Occupiers the Amount of Rate which he would be liable to pay under such Agreement, and also the further Sum of Forty Shillings for every Day during which they shall refuse or neglect to lay down such Pipes, or to provide such Supply of Water: Provided always, that the Undertakers shall not be liable to any Penalty for not supplying Water if the Want of such Supply shall arise from Frost, unusual Drought, or other unavoidable Cause or Accident."

Supply of Water to be kept for Cleansing Sewers, Drains, &c., and for other Public Purposes.

No. 36. XXXVII.—"In all the Pipes to which any Fire-plug shall be fixed the Undertakers shall provide and keep constantly laid on, unless prevented by Frost, unusual Drought, or other unavoidable Accident, or during necessary Repairs, a sufficient Supply of Water for the following Purposes; (that is to say,) for cleansing the Sewers and Drains, for cleansing and watering the Streets, and for supplying any Public Pumps, Baths, or Wash-houses that may be established for the free Use of the Inhabitants, or paid for out of any Poor Rates or Borough Rates levied within the limits of the Special Act; and such Supply shall be provided at such Rates, in such Quantities, and upon such Terms and Conditions as may be agreed upon by the Town Commissioners and the Undertakers, or, in case of Disagreement, as shall be settled in *England* or *Ireland* by Two Justices, and in *Scotland* by the Sheriff, until in either Case an Inspector shall have been appointed, and after the Appointment of such Inspector, by the Inspector so appointed."

Fire-plugs to be placed near Manufactories, at Request, &c., of Owners.

No. 37. XLI.—"The Undertakers shall, at the Request and Expense of the Owner or Occupier of any Work or Manufactory situated in any Street in which there shall be a Pipe of the Undertakers, place and maintain in effective Order, a Fire-plug (to be used only for extinguishing Fires) as near as conveniently may be to such Work or Manufactory."

Pipes to be kept charged and Water taken to extinguish Fires without Charge.

No. 38. XLII.—"The Undertakers shall at all Times keep charged with water, under such Pressure as aforesaid, all their Pipes to which Fire-plugs shall be fixed, unless prevented by Frost, unusual Drought, or other unavoidable Cause or Accident, or during necessary Repairs, and shall allow all Persons at all Times to take and use such Water for extinguishing Fire, without making Compensation for the same."

Penalty for Refusal to fix, &c., Fire-plugs, or occasional Failure of Supply of Water.

No. 39. XLIII.—"If, except when prevented as aforesaid, the Undertakers neglect or refuse to fix, maintain, or repair such Fire-plugs, or to furnish to the Town Commissioners a sufficient Supply of Water for the public purposes aforesaid, upon such Terms as shall have been agreed on or settled as aforesaid, or if, except as aforesaid, they neglect to keep their Pipes charged under such Pressure as aforesaid, or neglect or refuse to furnish to any Owner or Occupier entitled under this or the Special Act to receive a Supply of Water during any Part of the Time for which the Rates for such Supply have been paid or tendered, they shall be liable to a Penalty of Ten Pounds, and shall also forfeit to the Town Commissioners, and to every Person having paid or tendered the Rate, the Sum of Forty Shillings for every Day during which such Refusal or Neglect shall continue after Notice in Writing shall have been given to the Undertakers of the Want of Supply."

Pipes to be laid by the Undertakers.

"And with respect to the Communication Pipes to be laid by the Undertakers, be it enacted as follows:"

Undertakers to lay down Communication Pipes, on request of Occupier and with consent of Owners in Houses of limited Value. (See No. 42 and 43.)

No. 40. XLIV.—"The Undertakers shall, upon the request of the Owner of any Dwelling House in any Street in which Pipes shall have been laid down by them, the annual Value of which House shall not exceed Ten Pounds, or upon Request of the Occupier, with the Consent in Writing of the Owner or reputed Owner of any such House, or of the Agent of such Owner, and upon Payment or Tender of the Proportion of Water Rate in respect of such House by this or the Special Act made payable in advance, lay down Communication Pipes and other necessary Works for the supply of such House with Water for domestic or other Purposes, and shall keep the same in repair, and thereupon the Occupier of such House shall be entitled to have a sufficient Supply of Water for his domestic Purposes from the Undertakers; and the Undertakers may charge for such Pipes and Works, in addition to the Water Rate, such reasonable annual Rent as shall be agreed upon, or in case of Dispute, as shall be settled by such Inspector as aforesaid, when appointed, and in the meantime as shall in *England* or *Ireland* be settled by Two Justices, and in *Scotland* by the Sheriff; and such rent shall be chargeable on and recoverable from the Occupier, or, in his Default, from the Owner of such House, at the same Times and in the same Manner as Water Rates; and such Pipes and other Works shall not be subject to Distress or to the Landlord's Hypothec for Rent, nor to be taken in Execution under any Process of a Court of Law or Equity, or under any

Fiat or Sequestration in Bankruptcy, against such Occupier or against such Owner, unless he shall have become the Proprietor of the said Pipes and Works under the Provisions herein-after contained."

Penalty on Undertakers for refusal to lay Communication Pipes.

No. 41. XLV.—"If upon such Request and Consent, and upon Tender or Payment of such Proportion of Rate as aforesaid, the Undertakers for Seven Days neglect or refuse to lay down such Communication Pipes or other Works, they shall be liable to forfeit to the Person so making such Request the Sum of Five Pounds, and a further Sum of Forty Shillings for every Day during which such Refusal or Neglect shall continue after Seven Days from the making of such Request and Tender as aforesaid."

Undertakers to be at liberty to remove Pipes, and recover expenses of Owners or Occupiers. No greater Sum to be recovered from Occupiers than Amount of Rent due.

No. 42. XLVI.—"If the Occupier for the Time being of the House in which any such Communication Pipes or other Works and Engines shall have been laid down by the Undertakers refuse to pay for a Supply of Water, or if such House be unoccupied for Twelve Months, the Undertakers may demand from the Owner thereof Payment of the Amount of the Principal Money invested by them in providing and laying down such Communication Pipes and other Works and Engines; and if such Owner, after Ten Days' Notice given to him by the Undertakers, neglect or refuse to pay such Principal Money, the Undertakers may enter the House and remove such Pipes and other Works; and the Balance of such Principal Money, after deducting the Value of such Pipes and other Works, with all Arrear of Rent for such Pipes and Works, shall, in default of Payment, be recovered, with the Costs incurred, from the Owner or from the Occupier for the Time being in the same Manner as Water Rates are directed by this or the Special Act to be recovered: Provided always, that no greater Sum shall be recovered from any such Occupier than the Amount of Rent for the Time being owing by him, unless he refuse to discover the Amount of Rent owing by him; and that every such Occupier shall be entitled to deduct from the Amount of Rent payable by him the Sum so recovered from him, or which he shall have paid on Demand."

Owner to be at liberty to purchase the Pipes, and Pipes to be laid by the Undertakers.

No. 43. XLVII.—"The Owner or reputed Owner of any House where any such Communication Pipes or other Works shall have been laid down by the Undertakers may at any Time pay off the Amount then due to the Undertakers in respect of the Costs of providing and laying down such Pipes and Works, and all Rent to that Time due in respect thereof, and thereupon such Pipes and Works shall become the Property of such Owner, and all further Rent in respect thereof shall cease to accrue to Undertakers."

Pipes to be laid by the Inhabitants.

"And with with respect to the Communication Pipes to be laid by the Inhabitants, be it enacted as follows:"

Power to Inhabitants to lay Service Pipes, giving the Undertakers Notice of the same.

No. 44. XLVIII.—"Any Owner or Occupier of any Dwelling House or Part of a Dwelling House within the Limits of the Special Act who shall wish to have Water from the Waterworks of the Undertakers brought into his Premises, and who shall have paid or tendered to the Undertakers the Portion of Water Rate in respect of such Premises, by this or the Special Act directed to be paid in advance, may open the Ground between the Pipes of the Undertakers and his Premises, having first obtained the Consent of the Owners and Occupiers of such Ground, and lay any Leaden or other Pipes from such Premises, to communicate with the Pipes of the Undertakers, such Pipes to be of a Strength and Material to be approved of by the Undertakers [see weight of lead pipes, Clause 2 of page 270], or, in case of Dispute, to be settled in *England* or *Ireland* by Two Justices, and in *Scotland* by the Sheriff, or in either Case by the Inspector to be appointed as aforesaid: Provided always, that every such Owner or Occupier shall, before he begins to lay any such Pipe, give to the Undertakers Fourteen Days' Notice of his Intention to do so." [See Clause 24 of Waterworks Act, 1852, and also Clause 7 of the Regulations for Water Pipes, of August, 1871, sanctioned by the Board of Trade, and marked No. 7, page 270, also see No. 27, page 270, and also the following; also see No. 48, page 276.]

Communication with the Pipes of the Undertakers to be made under the Superintendence of their Surveyor. As to the settling of Disputes.

No. 45. XLIX.—"Before any Pipe is made to communicate with the Pipes of the Undertakers, the Person intending to lay such Pipe shall give Two Days' Notice to the Undertakers of the Day and Hour when such Pipe is intended to be made to communicate with the Pipes of the Undertakers; and every such Pipe shall be so made to communicate under the Superintendence and according to the Directions of the Surveyor or other Officer appointed for that Purpose by the Undertakers, unless such Surveyor or Officer fail to attend at the Time mentioned in the said Notice; and in case of any Dispute as to the Manner in which such Pipe shall be so made to communicate, it shall in *England* or *Ireland* be settled by Two Justices, and in *Scotland* by the Sheriff, or in either Case by the Inspector to be appointed as aforesaid." [See No. 7, page 270].

Bore of Service Pipes.

No. 46. L.—"The Bore of any such Pipe as last aforesaid shall not exceed the prescribed Limits, and where no Limit shall be prescribed it shall not exceed Half an Inch, except with the Consent of the Undertakers."

Service Pipes may be removed after giving Notice of the same. Penalty on removing Pipes without Notice.

No. 47. LI.—"Any Person who shall have laid down any Pipe or other Works, or who shall have become the Proprietor thereof, may remove the same, after having first given Six Days' Notice in Writing to the Undertakers of his Intention so to do, and of the Time of such proposed Removal; and every such Person shall make Compensation to the Undertakers for any Injury or Damage to their Pipes or Works which may be caused by such Removal; and every Person who shall remove any such Pipe or other Works without giving such Notice as aforesaid shall forfeit to the Undertakers a Sum not exceeding Five Pounds, over and above the Damage which he may be found liable to pay in any Action at Law, at the Suit of the Undertakers, for the Damage done to their Pipes or Works."

Power to Inhabitants to break up Pavements, giving Notice of same.

No. 48. LII.—"Any such Owner or Occupier may open or break up so much of the Pavement of any Street as shall be between the Pipe of the Undertakers and his House, Building, or Premises, and any Sewer or Drain therein, for any such Purpose as aforesaid, doing as little Damage as may be, and making Compensation for any Damage done in the Execution of any such Work: Provided always that every such Owner or Occupier desiring to break up the Pavement of any Street, or any Sewer or Drain therein, shall be subject to the same Necessity of giving previous Notice, and shall be subject to the same Control, Restriction, and Obligations in and during the Time of breaking up the same, and also reinstating the same, and to the same Penalties for any Delay in regard thereto, as the Undertakers are subject to by virtue of this or the Special Act."

Owners or Occupiers entitled to demand a Supply of Water for domestic Purposes.

No. 49. LIII.—"Every Owner and Occupier of any Dwelling House or part of a Dwelling House within the Limits of the Special Act shall, when he has laid such Communication Pipes as aforesaid, and paid or tendered the Water Rate payable in respect thereof, according to the Provisions of this and the Special Act, be entitled to demand and receive from the Undertakers a sufficient Supply of Water for his domestic Purposes." [In this Clause lies the whole of the consumer's right.]

Protection of Water.

"And with respect to Waste or Misuse of Water supplied by the Undertakers, be it enacted as follows:"

Persons using the Water to provide Cisterns and Cocks. Penalty for Neglect.

No. 50. LIV.—"If by the Special Act it be provided that the Water to be supplied by the Undertakers need not be constantly laid on under Pressure, every Person supplied with Water shall, when required by the Undertakers, provide a proper Cistern to hold the Water with which he shall be so supplied, with a Ball and Stop Cock, in the Pipe bringing the Water from the Works of the Undertakers to such Cistern, and shall keep such Cistern, Ball and Stop Cock in good Repair, so as effectually to prevent the Water from running to waste; and in case any such person shall, when required by the Undertakers, neglect to provide such Cistern, Ball or Stop Cock, or to keep the same in good Repair, the Undertakers may cut off the Pipe or turn off the Water from the Premises of such Person until such Cistern and Ball and Stop Cock shall be provided or repaired, as the case may require."

Penalty for suffering Cistern, &c., to be out of repair.

No. 51. LV.—"Every person supplied with Water by the Undertakers who shall suffer any such Cistern, Pipe, Ball or Stop Cock to be out of repair, so that the Water supplied to him by the Undertakers shall be wasted, shall forfeit to the Undertakers for every such Offence a Sum not exceeding Five Pounds."

Undertakers may repair Cisterns, &c., and recover the Expenses.

No. 52. LVI.—"The Undertakers may repair any such Cistern, Pipe, Ball or Stop Cock, so as to prevent any such Waste of Water, and the Expenses of such Repair shall be repaid to them by the Person so allowing the same to be out of repair, and may be received as Damages."

Power to Surveyor employed by Undertakers to enter Houses to inspect, &c.

No. 53. LVII.—"The Surveyor or any other Person acting under the Authority of the Undertakers, may, between the Hours of Nine of the Clock in the Forenoon and Four of the Clock in the Afternoon, enter into any House or Premises supplied with Water by virtue of this or the Special Act, in order to examine if there be any Waste or Misuse of such Water; and if such Surveyor or other Person at any such Time be refused Admittance into such Dwelling House or Premises for the Purpose aforesaid, or be prevented from making such Examination as aforesaid, the Undertakers may turn off the Water supplied by them from such House or other Premises."

Penalty for allowing Persons to use the Undertakers' Water.

No. 54. LVIII.—"Every Owner or Occupier of any Tenement supplied with Water under this or the Special Act who shall supply to any other Person or wilfully permit him to take any such Water from any Cistern or Pipe in such Tenement, unless for the Purpose of extinguishing any Fire, or unless he be a Person supplied with water by the Undertakers, and the Pipes belonging to him be, without his default, out of repair, shall forfeit to the Undertakers for every such Offence a Sum not exceeding Five Pounds."

Penalty for taking the Undertakers' Water without Agreement.

No. 55. LIX.—"Every Person who, not having agreed to be supplied with Water by the Undertakers, shall take any Water from any Reservoir, Watercourse, or Conduit belonging to the Undertakers, or any Pipe leading to any such Reservoir, Watercourse, or Conduit, or from any Cistern or other like Place containing Water belonging to the Undertakers, other than such as may have been provided for the gratuitous Use of the Public, shall forfeit to the Undertakers for every such Offence a Sum not exceeding Ten Pounds."

Penalty for destroying Valves, &c.

No. 56. LX.—"Every Person who shall wilfully or carelessly break, injure, or open any Lock, Cock, Valve, Pipe, Work, or Engine belonging to the Undertakers, or shall flush or draw off the Water from the Reservoirs or other works of the Undertakers, or shall do any other wilful Act whereby such Water shall be wasted, shall forfeit to the Undertakers for every such Offence a Sum not exceeding Five Pounds."

Water Rates.

"And with respect to the Payment and Recovery of the Water Rates, be it enacted as follows:

Rates to be payable according to the Annual Value of the Premises.

No. 57. LXVIII.—"The Water Rates, except as hereinafter and in the Special Act mentioned shall be paid by and be recoverable from the Person requiring, receiving, or using the supply of Water, and shall be payable according to the annual Value of the Tenement supplied with Water, and if any Dispute arise as to such Value the same shall be determined by Two Justices." [See Clause 21 of Water Act, 1863, No. 88, page 281.]

Where several Houses supplied by One Pipe each to pay.

No. 58. LXIX.—"When several Houses or Parts of Houses in the separate Occupation of several Persons are supplied by One common Pipe, the several Owners or Occupiers of such Houses or Parts of Houses shall be liable to the Payment of the same Rates for the Supply of Water as they would have been liable to if each of such several Houses or Parts of Houses had been supplied with Water from the Works of the Undertakers by a separate pipe."

Rates to be paid quarterly.

No. 59. LXX.—"The Rates shall be paid in advance by equal quarterly Payments, in *England* or *Ireland* at *Christmas Day*, *Lady Day*, *Midsummer Day*, and *Michaelmas Day*, and in *Scotland* at *Martinmas*, *Candlemas*, *Whitsuntide*, and *Lammas*, and the First Payment shall be made at the Time when the Pipe by which the Water is supplied is made to communicate with the Pipes of the Undertakers, or at the Time when the Agreement to take Water from the Undertakers is made."

Parties giving Notice to discontinue Use of Water, or removing, to pay to the next Quarter Day.

No. 60. LXXI.—"The Occupier of any Dwelling House or Part of a Dwelling House liable to the Payment of any Water Rate, who shall give Notice of his Intention to discontinue the Use of the Water supplied by the Undertakers, or who shall remove from his Dwelling between any Two quarterly Days of Payment, shall pay the Water Rate in respect of such Dwelling House or Part of a Dwelling House for the Quarter ending on the Quarterly Day of Payment next after his quitting the same or giving such notice."

Owners of Houses not exceeding £10 Rent to be liable to Water Rates.

No. 61. LXXIII.—"The Owners of all Dwelling Houses or Parts of Dwelling Houses occupied as separate Tenements, the annual Value of which Houses or Tenements shall not exceed the Sum of Ten Pounds, shall be liable to the Payment of the Rates instead of the Occupiers thereof; and the Powers and Provisions herein or in the Special Act contained for the Recovery of Rates from Occupiers shall be construed to apply to the Owners of such Houses and Tenements; and the Person receiving the Rents of any such House or Tenement as aforesaid from the Occupier thereof, on his own account, or as Agent or Receiver for any Person interested therein, shall be deemed the Owner of such House or Tenement."

Tenants under existing Leases to repay the Owner

No. 62. LXXIII.—"Provided always, That when any Owner shall pay any such Rate in respect of any such Dwelling House or Part of a Dwelling House which shall be in the Occupation of any Tenant under any Lease or Agreement made prior to the passing of the Special Act, such Tenant shall repay to the Owner all Sums which shall be so by him paid during the Continuance of such Lease, unless it have been agreed that the Owner shall pay the Water Rates in respect of such Dwelling House or Part of a Dwelling House; and every such Sum of Money payable by the Tenant to the Owner, under the Provision hereinbefore contained, may be recovered, if the same be not paid upon Demand, as Arrears of Rent could be recovered from the Occupier by the said Owner."

Rates, how to be recovered.

No. 63. LXXIV.—"If any Person supplied with Water by the Undertakers, or liable as herein or in the Special Act provided to pay the Water Rate, neglect to pay such Water Rate at any of the said Times of Payment thereof, the Undertakers may stop the Water from flowing into the Premises in respect of which such Rate is payable, by cutting off the Pipe to such Premises, or by such Means as the Undertakers shall think fit, and may recover the Rate due from such Person, if less than Twenty Pounds, with the Expenses of cutting off the Water and Costs of recovering the Rate, in the same Manner as any Damages for the Recovery of which no special Provision is made are recoverable by this or the Special Act; or if the Rate so due amount to Twenty Pounds or upwards, the Undertakers may recover the same, with the Expenses of cutting off the Water, by Action, in any Court of competent Jurisdiction."

Access to Special Act.

No. 64.—"And with respect to Access to the Special Act, be it enacted as follows":

Copies of Special Act to be kept by Undertakers in their Office and deposited with the Clerks of the Peace, &c., and to be open to Inspection.

XC.—"The Undertakers shall at all Times after the Expiration of Six Months after the passing of the Special Act keep in their principal Office of Business a Copy of the Special Act, printed by the Printers to Her Majesty [for this Act go to the Waterworks Company and ask for *their Special* Act, or apply to Spottiswoode and Co., 87, Chancery Lane, London], or some of them, and shall also within the Space of such Six Months deposit in the Office of the Clerk of the Peace in *England* or *Ireland*, and of the Sheriff Clerk in *Scotland*, of the County in which the Undertaking is situated, a Copy of such Special Act so printed as aforesaid; and the said Clerk of the Peace and Sheriff Clerk shall receive, and they and the Undertakers respectively shall keep, the said Copies of the Special Act, and shall allow all Persons interested therein to inspect the same, and make Extracts or Copies therefrom, in the like Manner and upon the like Terms, and under the like Penalty for Default, as is provided in the Case of certain Plans and Sections by an Act passed in the First Year of the Reign of Her Majesty, intituled *An Act to compel Clerks of the Peace for Counties and other Persons to take the Custody of such Documents as shall be directed to be deposited with them under the Standing Orders of either House of Parliament.*"

Penalty on Undertakers failing to keep or deposit such copies.

No. 65. XCI.—"If the Undertakers fail to keep or deposit any of the said Copies of the Special Act, as hereinbefore mentioned, they shall forfeit Twenty Pounds for every such Offence, and also Five Pounds for every Day afterwards during which such Copy shall not be so kept or deposited."

After the above Act had been in work some years, another was made on the 1st of July, 1852, entitled :—"An Act to make better Provision respecting the Supply of Water to the Metropolis, 1st July, 1852"; parts of which I shall quote, but only such parts as may be of use to the plumber:

ANNO DECIMO QUINTO AND DECIMO SEXTO.

VICTORIÆ REGINÆ.

CAP. LXXXIV.

An Act to make better Provision respecting the Supply of Water to the Metropolis. [1st *July*, 1852.]

For Clauses IX., X., XI. of this Act, see page 285, as it will there assist in reading No. 114, Clause 35, of 1881 Act.

Provision for Constant Supply of Water by every Company.

No. 66. XV.—After the Expiration of Five Years from the passing of this Act, every Company shall, subject to the Provisions of the Special Act relating to such Company, provide and keep, in the District Mains already laid down or hereinafter to be laid by them, a constant Supply of pure and wholesome Water sufficient for the domestic Use of the Inhabitants of all Houses supplied by such Company, at such Pressure as will make the Water reach the Top Story of the highest of such Houses, but not exceeding the Level prescribed by the Special Act of such Company: Provided, that no Company shall be bound to provide a constant Supply of Water to any District Main until Four Fifths of the Owners or Occupiers of the Houses on such Main shall by Writing under their Hands have required such Company to provide such Supply, nor even upon such Requisition, in case it can be shown by any Company objecting to the same that more than One Fifth of the Houses on such Main are not supplied with Pipes, Cocks, Cisterns, Machinery, and Arrangements of all Kinds for the Reception and Distribution of Water, constructed according to the regulations prescribed by the Special Act or by this Act, or which any Company, with the Approval of the Board of Trade, may from Time to Time make in that Behalf; and after any such Requisition as aforesaid shall have been delivered to the Company, it shall be lawful for the Surveyor, or any other Person acting under the Authority of the Company, between the Hours of Nine of the Clock in the Forenoon and Four of the Clock in the Afternoon, to enter into any House or Houses on such District Main, in order to ascertain whether the Pipes, Cocks, Cisterns, and Machinery of such House and Houses are so constructed as aforesaid; and provided also that any Company may, with the Consent of the Board of Trade, suspend the giving of such constant Supply, or give the same in succession to the several Districts of such Company or to any Parts of such Districts as may be found to be convenient; and provided that it shall be lawful for the Company, after due Notice, to abstain from supplying, or to cut off the Communication Pipes, and withdraw the Supply of Water from any House whereof the Pipes, Cocks, Cisterns, Machinery, or Arrangements as aforesaid, shall not be in conformity with such Regulations: Provided, that neither the *Kent* Waterworks Company nor the *Hampstead* Waterworks Company shall be required to give such supply at any Height exceeding One hundred and eighty Feet above *Trinity* High-water Mark, nor the *East London* Waterworks Company be required to give such supply at any Height exceeding Forty Feet above the Level of the Pavement nearest the Point at which such Supply shall be required.

[Here see Schedule B of the Water Act of 1871, which runs as follows:]

No. 67. Schedule B.—Parts of the Metropolis Water Act, 1852, which are referred to in section 5 of the foregoing Act, viz.:—
Section 15, except so much thereof as prescribes the height at which the Kent Waterworks Company and the East London Waterworks Company are respectively required to give their supply, sections 19 to 22, both inclusive, and section 27.

Penalty for Non-Compliance with the Provisions of the Act.

No. 68. XVI. — Any Company which shall violate, refuse, or neglect to comply with any of the provisions hereinbefore contained shall forfeit to Her Majesty the Sum of Two hundred Pounds, and the further Sum of One hundred Pounds for every Month during which they shall continue to violate or to refuse or neglect to comply with the same after they shall have received Notice in Writing from the Board of Trade to discontinue such Violation, Refusal, or Neglect as aforesaid.

Map of underground Works of the Company to be made, and kept at principal Office of each Company, and be open to Inspection.

No. 69. XVII. — Every Company shall, within One Year after the passing of this Act, cause a Map to be made of the District within which any Mains or District Mains shall have been laid down or formed by them on a Scale not less than Six Inches to a Mile, and shall cause to be marked thereon the Course and Situation of all existing Mains and District Mains, and shall, within Six Months from the making of any Alterations or Additions, cause the said Maps to be from Time to Time corrected, and such Additions made thereto as may show the Line and Situation of all such Mains and District Mains [here read district

pipes, see section 49, Water Act, 1871], as may be laid down or formed by them from Time to Time after the passing of this Act; and such Map or a Copy thereof, with the Date expressed thereon of the last time when the same shall have been so corrected as aforesaid, shall be kept in the principal Office of each Company, and shall be open to the Inspection of all Persons interested in the same within the said District, who shall be at liberty to take Copies of or Extracts from the same.

Companies to furnish Particulars of District Mains when required.

No. 70. XVIII.—Every Company on the Application of any Person supplied with Water by such Company, shall furnish to such Person the Particulars of any District Main [here read district pipes, see section 49, Water Act, 1871] from which such Person is supplied, together with the Names of the Streets through which such District Main [here read district pipes, see section 49, Water Act, 1871] passes, and the Commencement and Termination thereof.

Board of Trade may direct Prosecutions to enforce Provisions of Acts.

No. 71. XX.—Whenever it shall appear to the Board of Trade that any of the Provisions of this Act have been violated, or have not been complied with on the Part of any Company, or that any Company has acted or is acting in a Manner unauthorized by the Provisions of this Act, and it shall also appear to the said Board of Trade that it would be for the public Advantage that the Company should be restrained from so acting, the said Board of Trade shall certify the same to Her Majesty's Attorney General, and thereupon the said Attorney General shall proceed by Information, or by Action, Bill, Plaint, Suit at Law or in Equity, or other legal Proceeding, as the Case may require, to recover any Penalties which may have been incurred, or otherwise to enforce the due Performance of the said Provisions: and in case the Default of the Company shall consist in the Commission of some Act or Acts unauthorized by Law, then the said Attorney General, upon receiving such Certificate as aforesaid, shall proceed by Suit in Equity or such other legal Proceeding as the Nature of the Case may require, to obtain an Injunction or Order (which the Judge in Equity, or other Judge to whom the Application is made, shall be authorised and required to grant, if he shall be of opinion that the Act or Acts of the Company complained of is or are not authorized by Law), to restrain the Company from acting in such illegal Manner, or to give such other Relief as the Nature of the Case may require.

Prosecutions to be under the Sanction of Board of Trade and within One Year after the Offence.

No. 72. XXI.—No such Certificate as aforesaid shall be given by the said Board of Trade until Twenty-one Days after they shall have given Notice to the Company against or in relation to whom they shall intend to give such Certificate of their Intention to give such Certificate; and no Proceedings shall be commenced under the Authority of the said Board of Trade except within One Year after the offence shall have been committed.

Cisterns to be supplied with proper Ballcocks or other Apparatus.

No. 73. XXII.—Whenever Water shall be constantly laid on under Pressure in any District Main, every Person supplied with Water under Pressure by any Company through such Main shall, when required by the Company, provide a proper Cistern or other Receptacle for the Water with which he shall be so supplied, with an efficient Ball-cock or other like Apparatus; and if any Cistern or other Receptacle supplied with Water under Pressure shall be provided with or have any Overflow Spout, Waste Pipe, or other Means or Contrivance immediately connected or capable of being used therewith to carry off the Water from such Cistern or Receptacle, such Person shall be bound to give Notice to the Company of every such Overflow Spout, Waste Pipe, or other Means or contrivance and of the Situation thereof; and whether such Notice shall have been given or not, the Surveyor or any other Person acting under the authority of the Company may, between the Hours of Nine of the Clock in the Forenoon and Four of the Clock in the Afternoon, enter into any House in order to examine if there be any Waste, Misuse, or undue Consumption of Water by means of any Overflow Spout, Waste Pipe, or other Means or Contrivance; and in case any such Waste, Misuse, or undue Consumption of Water shall be found to exist, or shall be deemed likely to occur from the Use of any such Overflow Spout, Waste Pipe, or other Means or Contrivance, it shall be lawful for such Surveyor or other Person to give Notice to the Person so supplied with Water, either to repair and amend or to remove such Overflow Spout, Waste Pipe, or other Means or Contrivance; and if the same shall not be forthwith repaired and amended, or removed, in accordance with such Notice, it shall be lawful for the Company immediately thereafter to turn off the Water from the House, and to cease to supply the same with Water. [See No. 29, page 273.]

Cisterns, Closets, and Baths to be so constructed as to prevent Waste or the Flow or Return of impure Matter into the Mains, &c.

No. 74. XXIII.—Every Cistern or other Receptacle for Water, and every Closet, Soil-pan, and private Bath which shall be supplied with Water by any Company, shall be so constructed and used as effectually to prevent the Waste, Misuse, or undue Consumption of Water, and the Flow or Return of foul Air or other noisome or impure Matter into the Mains or Pipes of the Company, or into any Pipes connected or communicating therewith; and notwithstanding anything in "The Waterworks Clauses Act, 1847," or in this Act contained, no Company shall be bound to supply Water into any Cistern or other Receptacle for Water, Closet, Soil-pan, or private Bath, which shall not be so constructed and used.

Restricting Communication with Pipes of the Company.

No. 75. XXIV.—No Person shall make or lay down, or permit to be made or laid down, any Pipe or other Means or Contrivance for taking, using, or obtaining Water to communicate with any Pipe or Apparatus connected with any of the Mains or Pipes of any Company without giving such Notice, and except under such Superintendence and according to such Direction as is provided by "The Waterworks Clauses Act, 1847," with respect to the Communication Pipes to be laid by the Inhabitants. [See No. 44, page 275.]

Water may be cut off in certain Cases.

No. 76. XXV.—If any Person supplied with Water by any Company shall wilfully do or cause to be done any Act, Matter, or Thing in contravention of the Provisions of this Act, or of the Special Act relating to such Company, or of any Act incorporated therewith, or shall wilfully omit or neglect to do any Matter or Thing which under

such Provisions ought to be done for the Prevention of the Waste, Misuse, or undue Consumption, or the Contamination of the Water of the Company, it shall be lawful for the Company to turn off the Water supplied by them to such Person, and to cease to supply such Person with Water, and also to recover from such Person by Action or Suit in any Court of competent Jurisdiction the Amount of any Loss, Damage, or Injury which such Company may sustain by means or in consequence of any such Act, Matter, or Thing as aforesaid, or of any such wilful Omission or Neglect as aforesaid.

Regulations to be made with Approval of Board of Trade.

No. 77. XXVI.—It shall be lawful for any Company from Time to Time, with the Approval of the Board of Trade, to make such Regulations as shall be necessary or expedient for the Purpose of preventing the Waste or Misuse of Water, and therein, amongst other things, to prescribe the Size, Nature, and Strength of the Pipes, Cocks, Cisterns, and other Apparatus to be used, and to interdict any Arrangements, and the Use of any Pipes, Cocks, Cisterns, or other Apparatus, which may tend to such Waste or Misuse as aforesaid. [See No. 100, page 283.]

Parish Officers, with Consent of Vestry, may require Inhabitants to procure Supply of Water.

No. 78. XXVII.—If it appear to the Churchwardens and Overseers of the Poor of any Parish that any House in such Parish is without a proper Supply of Water, and that an annual Supply can be furnished thereto by the Company at a rate not exceeding Threepence *per* Week, conformably with the Scale of Rates authorized to be charged by such Company, after making the Allowance of Twenty *per Cent.* hereinafter mentioned, the said Churchwardens and Overseers shall, with the Consent of the Vestry of the said Parish, give Notice in Writing to the Owner or Occupier of such House, requiring him within a Time specified therein to obtain such supply, and do all such Works as may be necessary for that Purpose; and if such Notice be not complied with the said Churchwardens and Overseers shall, with the Consent aforesaid, do such Works, and recover the Expenses incurred from such Owner, in like Manner and with the same Remedies for Nonpayment, as Rates for the Maintenance of the Poor are by Law recoverable in such Parish; and the Company shall, upon the Requisition of the said Churchwardens and Overseers of the Poor, supply with Water such House or Houses; and the Rates for such Supply of such House or Houses, not exceeding in the whole Threepence *per* Week for any One such House, shall be due and payable by the said Owner, and shall be recoverable by the Company as if such Owner had contracted with the Company for the Supply of such Water, and upon such payment the Company shall make an Allowance of Twenty *per Cent.*; and for the Purposes aforesaid the Person for the Time being receiving the Rackrent of any such House as aforesaid, whether on his own Account or as Agent or Trustee for any other Person, or who would so receive the same if such House were let at a Rackrent, shall be deemed to be the Owner of such House.

After the Act of 1852 follows this short Waterworks Act of 28th of July, 1863.

ANNO VICESIMO SEPTO AND VICESIMO SEPTIMO.

VICTORIÆ REGINÆ.

CAP. XCIII.

An Act for consolidating in One Act certain Provisions frequently inserted in Acts relating to Waterworks.

Supply for other than Domestic Purposes.

And with respect to the supply of water to be furnished by the undertakers, be it enacted as follows:

No. 79. **12.**—A supply of water for domestic purposes shall not include a supply of water for cattle, or for horses, or for washing carriages where such horses or carriages are kept for sale or hire, or by a common carrier, or a supply for any trade, manufacture, or business, or for watering gardens, or for fountains, or for any ornamental purpose.

Want of Supply for other than Domestic Purposes, when excused.

No. 80. **13.**—Where the undertakers are authorized by the special Act to supply water for other than domestic purposes, they shall not be liable, in the absence of express stipulation, under any agreement for the supply of water for other than domestic purposes, to any penalty or damages for not supplying such water, if the want of such supply arises from frost, unusual drought, or other unavoidable cause or accident.

Power to let Meters for Hire.

No. 81. **14.**—Where the undertakers are authorized by the special Act to supply water by measure, they may let for hire to any consumer of water so supplied any meter or instrument for measuring the quantity of water supplied and consumed, and any pipes and apparatus for the conveyance, reception, or storage of the water, for such remuneration in money as may be agreed upon between them and the consumer, which shall be recoverable in the same manner as rates due to the undertakers for water; and the meters, instruments, pipes, and apparatus shall not be subject to distress or to the landlord's hypothec for rent of the premises where the same are used, or be attached or taken in execution under any process of any court of law or equity, or

under or in pursuance of any adjudication or order in bankruptcy, or other legal proceeding, against or affecting the consumer of the water, or the occupier of the premises, or other the person in whose possession the meters, instruments, pipes, and apparatus may be.

Power for Ascertaining Quantity Consumed by Meter, and for Removing Meters, &c.

No. 82. **15.**—The officers of the undertakers may enter any house, building, or lands to, through, or into which water is supplied by them by measure, in order to inspect the meters, instruments, pipes, and apparatus for the measuring, conveyance, reception, or storage of water, or for the purpose of ascertaining the quantity of water supplied or consumed, and may from time to time enter any house, building, or lands, for the purpose of removing any meter, instrument, pipe, or apparatus the property of the undertakers; and if any person hinder any such officer from entering or making such inspection, or effecting such removal, he shall for every such offence be liable to a penalty not exceeding five pounds; but, except with the consent of a justice or the sheriff, this power of entry shall be exercised only between the hours of ten in the forenoon and four in the afternoon.

And with respect to the waste or misuse of the water supplied by or belonging to the undertakers, be it enacted as follows:

Power to cut off Water in certain cases.

No. 83. **16.**—If any person supplied with water by the undertakers wrongfully does or causes or permits to be done anything in contravention of any of the provisions of the special Act, or wrongfully fails to do anything which, under any of those provisions, ought to be done for the prevention of the waste, misuse, undue consumption, or contamination of the water of the undertakers, they may (without prejudice to any remedy against him in respect thereof) cut off any of the pipes by or through which water is supplied by them to him, or for his use, and may cease to supply him with water, so long as the cause of injury remains or is not remedied.

Penalty for Waste, &c., of Water by Non-repair of Pipes, &c.

No. 84. **17.**—If any person supplied with water by the undertakers wilfully or negligently causes or suffers any pipe, valve, cock, cistern, bath, soil-pan, water-closet, or other apparatus or receptacle to be out of repair, or to be so used or contrived as that the water supplied to him by the undertakers is or is likely to be wasted, misused, unduly consumed, or contaminated, or so as to occasion or allow the return of foul air, or other noisome or impure matter, into any pipe belonging to or connected with the pipes of the undertakers, he shall for every such offence be liable to a penalty not exceeding five pounds.

Penalty for Application of Water contrary to Agreement.

No. 85. **18.**—If any person—

First, not having from the undertakers a supply of water for other than domestic purposes, uses, for other than domestic purposes, any water supplied to him by the undertakers; or

Secondly, having from the undertakers a supply of water for any other than domestic purposes, uses, for any purposes other than those for which he is entitled to use the same, any water supplied to him by the undertakers,—

he shall for every such offence be liable to a penalty not exceeding forty shillings, without prejudice to the right of the undertakers to recover from him the value of the water misused.

Penalty for Extension or Alteration of Pipes.

No. 86. **19.**—It shall not be lawful for the owner or occupier of any premises supplied with water by the undertakers, or any consumer of the water of the undertakers, or any other person, to affix or cause or permit to be affixed any pipe or apparatus to a pipe belonging to the undertakers, or to a communication or service pipe belonging to or used by such owner, occupier, consumer, or other person, or to make any alteration in any such communication or service pipe, or in any apparatus connected therewith, without the consent in every such case of the undertakers; and if any person acts in any respect in contravention of the provisions of the present section, he shall for every such offence be liable to a penalty not exceeding five pounds, without prejudice to the right of the undertakers to recover damages from him in respect of any injury done to their property, and without prejudice to their right to recover from him the value of any water wasted, misused, or unduly consumed.

Penalty for Use of Water without Agreement.

No. 87. **20.**—If any person, not being supplied with water by the undertakers, wrongfully takes or uses any water from any reservoir, water-course, conduit, or pipe belonging to the undertakers, or from any pipe leading to or from any such reservoir, water-course, conduit, or pipe, or from any cistern or other like place containing water belonging to the undertakers, or supplied by them for the use of any consumer of the water of the undertakers, he shall for every such offence be liable to a penalty not exceeding five pounds.

And with respect to the recovery of water rates and other money, be it enacted as follows:

Recovery of Rates by Action.

No. 88. **21.**—If any person refuses or neglects to pay to the undertakers any rate or sum due to them under the special Act, they may recover the same, with costs, in any court of competent jurisdiction; and their remedy under the present section shall be in addition to their other remedies for the recovery thereof.

After the above Acts the following came into force :—

METROPOLIS WATER ACT OF 1871.

CHAP. CXIII.

An Act to amend "The Metropolis Water Act, 1852," and to make further provisions for the due Supply of Water to the Metropolis and certain places in the neighbourhood thereof.

[21*st August*, 1871.]

Supply of Water on Sundays.

No. 89. **6.**—From and after the passing of this Act, every Company shall on Sundays as on other days supply sufficient pure and wholesome water for the domestic use of the inhabitants within their water limits.

Companies to Provide Constant Supply of Water.

No. 90. **7.**—Subject to the provisions of this Act, every Company may, and from and after the expiration of eight months from the passing of this Act every Company shall, when required so to do, in the manner directed by this Act, provide and keep throughout their water limits, or throughout such parts of such limits as they may be required in manner aforesaid, a constant supply of pure and wholesome water sufficient for the domestic purposes of the inhabitants within such water limits constantly laid on at such pressure as will make such water reach the top story of the highest houses within such water limits (but not exceeding the level prescribed by the special Act) of such Company (which supply is in this Act referred to as a "constant supply"); and every such Company shall, subject to the provisions of the special Act as the same are amended by this Act, give and continue to give to such inhabitants a constant supply for domestic purposes in manner prescribed.

Application for Constant Supply.

No. 91. **8.**—At any time after the expiration of six months from the passing of this Act, the metropolitan authority shall, whenever they are of opinion that there should be in any district a constant supply, make application to the Company within the water limits in which such district is situate, requiring a constant supply in such district, and any Company may without any such application propose to the metropolitan authority to give a constant supply in any district.

Appeal to Board of Trade.

No. 92. **9.**—When application has been made to any Company requiring such Company to provide a constant supply, or when any Company has given notice to a metropolitan authority of a proposal to give a constant supply in any district, and the Company so required, or the metropolitan authority upon whom notice of such proposal has been served, object to such requisition or proposal, it shall be lawful for such Company or metropolitan authority, within one month after the making of such application or service of such notice, to present a memorial to the Board of Trade, setting forth their objections to such requisition or proposal, and the party presenting such memorial, or such Company, shall give notice to the other party of the presentation of such memorial, and shall transmit to such party a copy of the same. The Board of Trade shall, as soon as conveniently may be after the receipt of such memorial, take the same into their consideration, and may, if they think fit, institute any inquiry in relation thereto, and may hear such Company and authority desiring to be heard, and may make such order in reference thereto, and as to the costs thereof and incident to the same, as to them shall seem just.

Restriction as to Compulsory Supply to Companies.

No. 93. **10.**—No Company shall be compelled to give a constant supply to any premises in any district until the regulations provided for by this Act are made and are in operation within such district, or if it can be shown by such Company that at any time after the expiration of two months from the time of the service of any requisition for constant supply more than one-fifth of the premises in such district are not provided with the prescribed fittings, without prejudice, nevertheless, to any renewed requisition at a future period.

In any district in which any default in respect of the prescribed fittings shall be found, the metropolitan authority may by notice in writing require the owner or occupier of any such premises, within a time to be specified in such notice, to provide the prescribed fittings, or to cause the fittings in such premises to be repaired so as to prevent any waste of water, and if any person fail to comply with the terms of such notice, the metropolitan authority may provide for such premises the prescribed fittings, or repair the fittings within the same, as the case may be.

The expenses incurred by the metropolitan authority in providing such fittings or in making such repairs shall be paid to them by the person liable to pay the rate for the water supplied, or on whose credit the water is supplied, or by the owner of the premises.

All such expenses may be recovered, with costs, from the owner, and to the extent of any rent due by the occupier of the premises, from such occupier, by proceedings in a court of summary jurisdiction, or by action in any court having jurisdiction locally in the matter, as if the same were an ordinary simple contract debt; and any sum and costs so recovered from an occupier may be deducted by him from the rent payable by him to the owner, and shall be allowed by the owner and every other person interested in the rent, as if the same had been actually paid as rent; but if in any case an occupier fails to disclose the amount of rent due by him, or the name or address of the owner, he shall be liable to pay the full amount of such expenses and costs: Provided further, that as between any such owner and occupier nothing herein contained shall be taken to affect any con-

tract made between them respecting the payment of the expenses of any such works as aforesaid.

Power to Board of Trade to require Constant Supply in certain cases.

No. 94. **11.**—It shall be lawful for the Board of Trade, at any time after the expiration of six months from the passing of this Act, to require a constant supply to be provided in any district by the Company within the water limits of which such district is situate, upon complaint made, and in case it appears to such Board, after due inquiry,—

That the metropolitan authority refuses to make or unreasonably delays making application for such constant supply, or

That, by reason of the insufficiency of the existing supply of water in such district, or the unwholesomeness of such water in consequence of its being improperly stored, the health of the inhabitants of such district is or is likely to be prejudicially affected.

Notice requiring or proposing Constant Supply to be served upon Company or Metropolitan authority.

No. 95. **12.**—Where a constant supply is required in any district, notice to that effect shall be served, on behalf of the party requiring the same, upon the Company required to provide such supply; and where a constant supply is proposed to be given in any district by any Company, notice to that effect shall be served on behalf of such Company upon the metropolitan authority. In every such notice shall be stated accurately the district in which such constant supply is required or proposed to be given, and the day (not being an earlier day than four months after the date of the service of such notice) upon and from which such supply is to commence.

Extension of time to Companies.

No. 96. **13.**—Where a constant supply is required in any district, and the Company is unable, from want of funds or other cause of any kind, to execute all the necessary works within the time prescribed by this Act, the Board of Trade, if they think fit, may extend the time for the giving of such supply generally, or may extend the time, and direct such supply to be given at different times in succession, to the several parts of such district, in such manner as may be found most convenient: Provided, that application be made by the Company for such extension of time within one month after the notice referred to in the last preceding section has been served upon them.

Provision for Supply in Courts, Passages, &c.

No. 97. **14.**—With respect to cases where a group or number of dwelling-houses are situate in a court or passage, or otherwise in contiguity with or in close neighbourhood to one another, the following further provisions shall have effect; that is to say,

(1.) If at any time it appears to the Board of Trade, on the report of the nuisance authority, as defined by the Sanitary Act, 1866 [apply to Spottiswoode for this Act, title, "The Sanitary Act of 1866" will be sufficient], that a constant supply cannot be well and effectually provided for that group or number of dwelling-houses, except by means of a stand-pipe or other apparatus placed outside the dwelling-houses, the Board of Trade may from time to time make an order to the effect that such group or number of dwelling-houses may be so supplied, and shall serve the same on the Company within whose water limits the dwelling-houses are situate:

(2.) If the requisite stand-pipe or other apparatus in accordance with the regulations of the Company is provided, then the Company shall give to those dwelling-houses a supply accordingly by means of the stand-pipe or other apparatus so provided, and on giving such supply shall be entitled to receive and recover water rates or rents from the owners or occupiers of such dwelling-houses as if the supply had been given in the premises. The expense of providing such stand-pipe or other apparatus shall be borne by the owner of the dwelling-houses, or if there is more than one owner then by the respective owners in such proportions as the Board of Trade shall direct:

(3.) The Board of Trade may at any time abrogate, wholly or in part, the order, or may originally grant it only for a limited period.

Provision for case of Frost, &c.

No. 98. **15.**—Notwithstanding anything in this Act, a Company shall not be subject to any liability for not giving a constant supply if the want of such supply arises from frost, unusual drought, or other unavoidable cause or accident.

Penalties for Non-compliance with preceding Provisions.

No. 99. **16.**—Any Company which violates, refuses, or neglects to comply with any of the preceding provisions of this Act shall be liable to a penalty not exceeding two hundred pounds, and to a further penalty not exceeding one hundred pounds for every month during which such violation or refusal or neglect to comply with the said provisions continues after they shall have received notice in writing from the Board of Trade to discontinue such violation, refusal, or neglect as aforesaid.

Company may Make Regulations.

No. 100. **17.**—Every Company shall, within six months after the passing of this Act, make regulations for the purposes for which regulations may be made under the authority of section 26 of the Metropolis Water Act, 1852, and the provisions of that section shall apply also to the preventing of undue consumption or contamination of water. [See No. 77, page 280.]

Amendment of Regulations.

No. 101. **18.**—Any Company, if it thinks fit, or if requested so to do by the Board of Trade, may repeal or alter any of the regulations made for the purposes aforesaid, or make new regulations instead of any of the same.

In case of Default by Companies, Board of Trade may appoint Person to Report as to Regulations, and may Make same.

No. 102. **19.**—In case any Company does not make regulations within the time specified in this Act, or in case any Company, on being requested in writing by the metropolitan authority, or by any ten consumers of the water supplied by that Company, to repeal or alter any of the regulations for the time being in force, or to make new regulations instead of any of the same, refuses so to do, the Board of Trade may, if they think fit, appoint a competent and impartial person of engineering knowledge and ex-

perience to report to them as to such regulations as may be necessary for the execution of this Act, or as to the expediency of altering or repealing such regulations, or of making new regulations, in conformity with such request as aforesaid, and on the report of such person the Board of Trade may make such regulations, repeal, or alterations as they think fit.

Penalties for Offences against Regulations.

No. 103. **20.** By any regulations made under the authority of the Metropolis Water Act, 1852, or of this Act, penalties may be imposed for offences against the same not exceeding in respect of any offence the sum of five pounds, so that every such regulation be so framed as to allow part only of the maximum penalty being inflicted, and any such penalty shall be recoverable as penalties under this Act are recoverable.

Confirmation of Regulations.

No. 104. **22.**—No regulation, and no repeal or alteration of any regulation, made under the authority of the Metropolis Water Act, 1852, or of this Act, by a Company, shall be of any force or effect unless and until the same be submitted to and confirmed by the Board of Trade, who may institute such inquiry in relation thereto as they shall think fit, and who at such inquiry shall hear the metropolitan authority, and the Company, if desiring to be heard, and the said Board shall, if they think fit, or if requested, nominate and have present at such inquiry to advise and assist them a competent and impartial waterworks engineer.

The Board of Trade may, after such inquiry, confirm or disallow any such regulation, repeal, or alteration, in whole or in part, or may confirm the same with such modification or alteration as they may think proper; and no such regulation, repeal, or alteration shall be made by the Board of Trade on any such report as aforesaid, except after a like inquiry and hearing, with the like advice and assistance as aforesaid: Provided that no such regulation, repeal, or alteration shall be confirmed or made (as the case may be) by the Board of Trade unless notice in that behalf shall have been given by the Company to which the same relates, or by such person as the Board of Trade direct, in the "London Gazette" and in two daily morning newspapers circulated within the limits of this Act, one month at least before the inquiry; and one month at least before any such inquiry is held a copy of the regulation, repeal, or alteration in question shall be sent by such Company or person to the office of the metropolitan authority, and the same shall for one month be kept open during office hours at the respective offices of the metropolitan authority and of the said Company to the inspection of all persons, without fee or reward, and a copy of the same or of any part thereof shall be furnished to every person who shall apply for the same, on payment of sixpence for every one hundred words contained in such copy.

Publication of Regulations.

No. 105. **23.**—A printed copy of all regulations in force for the time being shall be kept at the office of the metropolitan authority and of every Company within the limits of this Act, and all persons may at all reasonable times inspect such copy without payment, and each Company shall cause to be delivered a printed copy, authenticated by their seal, of all regulations for the time being in force to every person applying for the same, on payment of any sum not exceeding one shilling and sixpence for every such copy, and a printed copy of the regulations for the time being in force relative to any particular district only to every person applying for the same, on payment of any sum not exceeding threepence for every such copy.

Notice relating to Constant Supply to be published in "London Gazette," &c.

No. 106. **26.**—When notice in relation to a constant supply in any district has been served upon or by any Company, the party by whom or on whose behalf such notice shall be served shall, within five days after the service thereof, cause to be published a copy of the same once in the "London Gazette," and copies of the same once at least in each of two successive weeks in any two daily newspapers circulated within the limits of this Act.

Company may Issue Notice upon Owners and Occupiers to Provide prescribed Fittings.

No. 107. **27.**—Where in any district any Company is required or has proposed to provide a constant supply, such Company may, at any time after the expiration of one month after the publication in the "London Gazette" of a copy of the notice requiring or proposing such constant supply, unless a memorial or application has been presented or made to the Board of Trade objecting to such constant supply or seeking an extension of time, and if any such memorial or application has been presented or made, then at such time after the determination of the Board of Trade in relation to such memorial or application as such Board shall approve and order, cause to be served on the owner or occupier of any premises within such district a notice requiring such owner or occupier to supply such premises with the prescribed fittings.

Owner or Occupier to Provide prescribed Fittings.

No. 108. **28.**—Every owner or occupier of premises upon whom notice to that effect has been served shall, within two months after the date of the service of such notice, provide the prescribed fittings, and shall from time to time keep the same in proper repair.

In case of Default by Owner or Occupier, Company may Provide or Repair prescribed Fittings.

No. 109. **28.**—Where in any district any Company is required or has proposed to provide a constant supply, and

Any owner or occupier of premises upon whom notice to provide prescribed fittings has been served by such Company makes default in providing the prescribed fittings, such Company, if they think fit, may provide such fittings; or

Where in any such district the fittings of any person are out of order, and not as prescribed, such Company may by notice in writing require such person, within twenty-four hours after the date of the service of such notice, to cause the same to be repaired, so as to prevent any waste of water; and if any person fail to comply with the terms of such notice such Company (if they think fit) may repair the fittings of such person.

The expenses incurred by such Company in providing such fittings or in making such repairs shall be paid to them by the person liable to pay the rate for the water supplied or on whose credit the water is supplied by means of such fittings, or by the owner of the premises.

All such expenses may be recovered, with costs, from the owner, and to the extent of any rent due by the occupier of the premises from such occupier, by proceedings in a court of summary jurisdiction, or by action in any court having jurisdiction locally in the matter, as if the same were an ordinary simple contract debt; and any sum and costs so recovered from an occupier may be deducted by him from the rent payable by him to the owner, and shall be allowed by the owner and every other person interested in the rent, as if the same had been actually paid as rent; but if in any case an occupier fails to disclose the amount of

rent due by him, or the name or address of the owner, he shall be liable to pay the whole amount of such expenses and costs: Provided, that as between any such owner and occupier nothing herein contained shall be taken to affect any contract made between them respecting the payment of the expenses of any such works as aforesaid.

Power to Enter Premises for Inspection and Repair of Fittings.

No. 110. **30.**—Where in any district any Company is required or has proposed to provide a constant supply, the officers or agents of such Company, or of the party requiring such supply, or any person appointed for such purpose by the Board of Trade may, at all reasonable times, enter any premises within such district, in order to inspect the premises for the purposes of this Act, and examine the same with a view to ascertain whether there are in or about the same the prescribed fittings, or, where authorised under the provisions of this Act, to provide or repair the fittings; and if any person hinder any such officer, agent, or person from entering and making such inspection or examination, or providing or repairing such fittings, every person so offending shall for every such offence be liable to a penalty not exceeding five pounds.

Settlement of Disputes as to Sufficiency, &c., of Fittings.

No. 111. **31.**—In the event of any dispute as to whether the fittings of any person are as prescribed, such dispute shall be settled by the court of summary jurisdiction, on the application of either party, which court may make such order as to the amount of the costs of the proceedings before such court as seems just, and the decision of such court shall be final and binding on all parties.

Penalties for Non-compliance with the Provisions of Act.

No. 112. **32.**—Where in any district any Company is required or has proposed to provide a constant supply,—

If any person supplied with water by such Company wilfully or negligently causes or suffers any fittings to be out of repair, or to be so used or contrived as that the water supplied to him by such Company is or is likely to be wasted, misused, unduly consumed, or contaminated, or so as to occasion or allow the return of foul air or other noisome or impure matter into any pipe belonging to or connected with the pipes of such Company, he shall for every such offence be liable to a penalty not exceeding five pounds; or

If any person supplied with water by such Company wrongfully does or causes or permits to be done anything in contravention of any of the provisions of the special Act or this Act, or wrongfully fails to do anything which, under any of those provisions, ought to be done for the prevention of the waste, misuse, undue consumption, or contamination of the water of such Company, they may (without prejudice to any remedy against him in respect thereof) cut off any of the pipes by or through which water is supplied by them to him or for his use, and may cease to supply him with water, so long as the cause of injury remains or is not remedied; and in every case of so cutting off or ceasing to supply, the Company shall within twenty-four hours thereafter give to the nuisance authority, as defined by the Sanitary Act, 1866, notice thereof.

Absence of proper Water Fittings in Premises to be a Nuisance.

No. 113. **33.**—The absence in respect of any premises of the prescribed fittings after the prescribed time shall be a nuisance within section 11 and sections 12-19 (inclusive) of the Nuisances Removal Act for England, 1855, and within all provisions of the same or any other Act applying, amending, or otherwise relating to those sections; and that nuisance, if in any case proved to exist, shall be presumed to be such as to render the premises unfit for human habitation within section 13 of the Nuisances Removal Act for England, 1855, unless and until the contrary is shown to the satisfaction of the justices acting under that section.

Power to Board to appoint Persons to inquire and report as to Quality of Water.

No. 114. **35.**—The Board of Trade may at any time, if and when they think fit, appoint a competent person to inquire into and report on the quality of the water furnished by any Company, notwithstanding that no complaint has been made and signed by twenty inhabitant householders, as prescribed by Section 9 of the Metropolis Water Act, 1852; and sections 10 and 11 and 13, and the other provisions of that Act, shall apply in every respect as if such person were appointed under section 9 of that Act, and as if any matter reported to the Board of Trade as requiring alteration on the part of a Company had been the subject of a complaint by such householders as aforesaid.

I have here appended the following Clauses IX., X., XI., of the Water Works Act, for convenience sake :—

CLAUSES IX., X., AND XI. OF THE WATER-WORKS ACT, 1852.

On Complaint as to Quantity and Quality Board of Trade may appoint a Person to Inquire and Report.

IX.—If at any Time Complaint as to the Quantity or Quality of the Water supplied by any Company for domestic Use be made to the Board of Trade by Memorial in Writing signed by not less than Twenty Inhabitant Householders paying Rents for and supplied with Water by the Company, it shall be lawful for the Board of Trade at any Time within One Month after the Receipt of such Complaint, to appoint a competent Person to inquire into and concerning the Grounds of such Complaint, and to report to the Board of Trade thereon.

Powers of Person Appointed.

X.—The Person so appointed as aforesaid shall, within Three Days after such Appointment, give Notice thereof in Writing to the Company, and after such Notice as aforesaid he shall have power to inspect and examine the Waterworks of the Company, and to inquire into and concerning the Grounds of such Complaint; and the Company and their Officers shall afford all reasonable Facilities for such Inspection, Examination, and Inquiry.

Penalty for Obstructing Inspector.

XI.—Any Person obstructing such Inspector in the due Prosecution of such Inspection, Examination, or Inquiry, shall forfeit and pay any Sum not exceeding Ten Pounds.

Appointment and Duties of Water Examiner.

No. 115. **36.**—There shall be a water examiner, being a competent and impartial person, from time to time appointed by and removable by the Board of Trade, who shall from time to time, in such manner as the Board of Trade direct,

examine the water supplied by any Company, in order to ascertain whether or not the Company have complied with the requirements of section 4 of the Metropolis Water Act, 1852, and shall from time to time report the results of his several examinations to the Board of Trade; and the Board of Trade shall send a copy of every such report to the Company to which the same relates, and the Company may if they think fit, on each occasion of such examination, be represented thereat by some officer, but such officer shall not interfere in the examination.

There shall be paid to such water examiner such remuneration by the Companies in such proportions as such Board appoints.

Incoming Tenant not to pay Arrears of Outgoing Tenant, unless by Express Agreement.

No. 116. **48.**—In case any consumer leave the premises where water was supplied to him without paying to the Company the rate due from him, the Company shall not require from the next tenant of the premises payment of the arrears so left unpaid, unless the incoming tenant agreed with the defaulting consumer to pay the arrears, but the Company shall, notwithstanding any such arrears, supply water to the incoming tenant, on being required by him so to do.

Amendment of Sections 17 and 18 of Metropolis Water Act, 1852.

No. 117. **49.**—Sections 17 and 18 of the Metropolis Water Act, 1852, shall be read as if instead of the words "district mains" and "district main" in the said sections the words "pipes" and "pipe" were substituted respectively; and every Company shall, upon the Map, and upon every alteration of the same made in conformity with the provisions of the said section 17, as amended by this section, cause to be marked every screw-cock or apparatus by means of which water is permitted to flow or is prevented from flowing from the main into any pipe within the water limits of such Company.

DRAINAGE MATTERS, Etc.

There are Acts of Parliament for Local Management of Drainage Works. And, as I have given a few pages to this work for the benefit of the plumber, I cannot do better than refer to some of the clauses contained in the Acts of Parliament which govern such work. I shall, therefore, first refer to the Act of 1855.

ANNO DECIMO OCTAVO AND DECIMO NONO.

VICTORIÆ REGINÆ.

CAP. CXX.

An Act for the better Local Management of the Metropolis. [14*th August*, 1855.]

Vestry or District Board in certain Cases may compel Owners, &c. of Houses to construct Drains into the Common Sewer. Penalty on Owner, &c., for Neglect.

No. 118. LXXIII.—"If any House or Building, whether built before or after the Commencement of this Act, situate within any such Parish or District, be found not to be drained by a sufficient Drain communicating with some Sewer, and emptying itself into the same, to the Satisfaction of the Vestry or Board of such Parish or District, and if a Sewer of sufficient Size be within One hundred Feet of any Part of such House or Building on a lower Level than such House or Building, it shall be lawful for the Vestry or Board, at their Discretion, by Notice in Writing, to require the Owner of such House or Building forthwith, or within such reasonable Time as may be appointed by the Vestry or Board, to construct and make from such House or Building into any such Sewer a covered Drain, and such Branches thereto, of such Materials, of such Size, at such Level, and with such Fall as shall be adequate for the Drainage of such House or Building, and its several Floors or Stories, and also of its Areas, Water-closets, Privies, and Offices (if any), and for conveying the Soil, Drainage, and Wash therefrom into the said Sewer, and to provide fit and proper paved or impermeable sloped Surfaces for conveying Surface Water thereto, and fit and proper Sinks, and fit and proper siphoned or otherwise trapped Inlets and Outlets for hindering Stench therefrom, and fit and proper Water Supply and Water supplying Pipes, Cisterns, and Apparatus for scouring the same, and for causing the same to convey away the Soil, and fit and proper Sand Traps, expanding Inlets [this only a wide-mouthed Gully Trap with Strainer], and other Apparatus for hindering the Entry of improper Substances therein, and all other such fit and proper Works and Arrangements as may appear to the Vestry or Board, or to their Officers, requisite to secure the safe and proper working of the said Drain, and to prevent the same from obstructing or otherwise injuring or impeding the Action of the Sewer to which it leads; and it shall be lawful for the said Vestry or Board to cause the said Works to be inspected while in progress, and from Time to Time during their Execution to order such reasonable Alterations therein, Additions thereto, and Abandonment of Part or Parts thereof, as may to the Vestry or Board or their Officers appear, on the fuller Knowledge afforded by the opening of the Ground, requisite to secure the complete and perfect

working of such Works; and if the Owner of such House or Building neglect or refuse, during Twenty-eight Days after the said Notice has been delivered to such Owner, or left at such House or Building, to begin to construct such Drain and other Works aforesaid, or any of them, or thereafter fail to carry them on and complete them with all reasonable Despatch, it shall be lawful for the Vestry or Board to cause the same to be constructed and made and to recover the Expenses to be incurred thereby from such Owner in the Manner herein-after provided."

Provision for Combined Drainage of Blocks of Houses.

No. 119. LXXIV.—"If it appear to the Vestry or Board of any Parish or District that a Group or Block of contiguous Houses, or of adjacent detached or semi-detached Houses, may be drained and improved more economically or advantageously in combination than separately, and a Sewer of sufficient Size already exist or be about to be constructed within One hundred Feet of any Part of such Group or Block of Houses, whether contiguous, detached, or semi-detached, it shall be lawful for such Board or Vestry to order that such Group or Block of Houses be drained and improved, as herein-before provided, by a combined Operation."

No House to be built without Drains constructed to the Satisfaction of the Vestry or District Board.

No. 120. LXXV.—"It shall not be lawful to erect any House or other Building in any Parish mentioned in Schedule (A) to this Act, or in any District mentioned in Schedule (B) to this Act, or to rebuild any House or Building within any such Parish or District which has been pulled down to or below the Floor commonly called the Ground Floor, or to occupy any House or Building so newly built or rebuilt, unless a Drain and such Branches thereto and other connected Works and Apparatus and Water Supply as herein-before mentioned be constructed and provided to the Satisfaction of the Surveyor of the Vestry of such Parish or Board of Works for such District, of such Materials, of such Size, at such Level, and with such Fall as they may direct, so that the same shall be available for the Drainage of the lowest Floor of such House or Building, and of its several Floors or Stories, and also of its Areas, Waterclosets, Privies, and Offices (if any), which Drain shall lead from such House or Building, or the intended Site of such House or Building, to such Sewer, already made or intended to be constructed near thereto, as the Vestry or Board shall direct and appoint, or if there be no such Sewer existing or intended to be constructed within One hundred Feet of any Part of the intended Site of such House or Building, then to such covered Cesspool or other Place, not being under any Dwelling House, as the Vestry or Board shall direct; and whenever any House or Building is rebuilt as aforesaid, the Level of the lowest Floor of such House or Building shall be raised sufficiently to allow of the Construction of such a Drain and such Branches thereto and other Works and Apparatus as are herein-before required, and for that Purpose the Levels shall be taken and determined under the Direction of the Vestry or District Board."

Notice of Buildings to be given to the Vestry or District Board before commencing the same.

No. 121. LXXVI.—"Before beginning to lay or dig out the Foundation of any new House or Building within any such Parish or District, or to rebuild any House or Building therein, and also before making any Drain for the Purpose of draining directly or indirectly into any Sewer under the Jurisdiction of the Vestry or Board of or for any such Parish or District, Seven Days' Notice in Writing shall be given to the Vestry or Board by the Person intending to build or rebuild such House or Building or to make such Drain; and every such Foundation shall be laid at such Level as will permit the Drainage of such House or Building in compliance with this Act, and as the Vestry or Board shall order, and every such Drain shall be made in such Direction, Manner, and Form, and of such Materials and Workmanship, and with such Branches thereto and other connected Works and Apparatus and Water Supply as herein-before mentioned, and as the Vestry or Board shall order, and the making of every such Drain shall be under the Survey and Control of the Vestry or Board; and the Vestry or District Board shall make their Order in relation to the Matters aforesaid, and cause the same to be notified to the Person from whom such Notice was received within Seven Days after the Receipt of such Notice, and in default of such Notice, or if such House, Building, or Drain, or Branches thereto or other connected Works and Apparatus and Water Supply be begun, erected, made, or provided in any respect contrary to any Order of the Vestry or Board made and notified as aforesaid, or the Provisions of this Act, it shall be lawful for the Vestry or Board to cause such House or Building to be demolished or altered, and to cause such Drain or Branches thereto and other connected Works and Apparatus and Water Supply to be relaid, amended, or re-made, or, in the event of Omission, added, as the Case may require, and to recover the Expenses thereof from the Owner thereof in the Manner herein-after provided."

Power to branch Drains into Sewers constructed by Metropolitan Board, or any Vestry or District Board under certain Regulations. Penalty.

No. 122. LXXVII.—"It shall be lawful for any Person, at his own Expense, to make or branch any Drain into any of the Sewers vested in the Metropolitan Board of Works or any Vestry or District Board under this Act, or authorized to be made by them under this Act, such Drain being of such a Size, and of such Conditions, and branched to such Sewer, in such a Manner and Form of Communication in all respects as the Vestry or Board shall direct or appoint; and in case any Person make or branch any Drain into any of the said Sewers so vested in the Vestry or Board, or authorized to be made by them under this Act, of a larger Size, or of different Conditions, or in a different Manner and Form of Communication than shall be directed or appointed by the Vestry or Board, every Person so offending shall for every such Offence forfeit a Sum not exceeding Fifty Pounds."

Power to Metropolitan Board or Vestry or District Board to branch Private Drains into Sewers, at the Expense of the Party to whom they belong.

No. 123. LXXVIII.—Whenever it is necessary to open any part of the Pavement of any Street or Public Place, for the Purpose of making or branching any private Drain into any of the Sewers or Drains vested in the Metropolitan Board of Works, or any Vestry or District Board under this Act, or authorized to be made by them under this Act, it shall be lawful for the Vestry or Board, in case they think fit so to do, to make so much and such part of such private Drain, and also to construct so much and such Part of the Work necessary for branching the same into the public Sewers as shall be under or in any Street, and to recover the Expenses incurred thereby from the Owner of the House, Building, or Ground to which such Private Drain belongs, in the Manner herein-after provided.

Vestry or District Board may agree to make House Drains at the Expense of Owners or Occupiers.

No. 124. LXXIX.—It shall be lawful for any such Vestry or Board to contract and agree with the Owners or Occupiers of any Houses, Buildings, or Ground that any Drains required to be made, altered, or enlarged by such Owners shall be constructed, made, altered, and enlarged by the Vestry or Board; and the Cost Price of making, altering, or enlarging such Drains, as certified by the Surveyor of the Vestry or Board, shall be repaid by the Owner or Occupier so agreeing to the Vestry or Board, and in default of Payment the same may be recovered in the Manner herein-after provided.

Vestry or District Board may order a Contribution towards Construction of Sewers in certain Cases.

No. 125.—LXXX.—Where any Sewer in any of the Parishes mentioned in either of the Schedules (A.) and (B.) to this Act, into which any Drain shall be made or branched, has been built since the Third Day of *September* One thousand eight hundred and thirteen, and before the Commencement of this Act, at the Expense of any Person or Body other than any Commissioners of Sewers, the Vestry or District Board in whom such Sewer is vested may order such Sum as they may deem just to be paid and contributed by the Owner of the House to which such Drain belongs towards the Expense of the Construction of such Sewer, which Sum shall, on the Receipt thereof by such Vestry or Board, be paid over to the Person or Body aforesaid, and such Vestry or Board may, if they see fit, order and accept Payment of such Sum, with Interest after a Rate not exceeding Five Pounds for the Hundred by the Year, by Instalments within any Period not exceeding Twenty Years.

Penalty on erecting or re-building Houses without proper Waterclosets, &c. Power to Vestry, &c., to require Owners, &c., to provide sufficient Waterclosets, &c. If Owners fail, Vestry, &c., to cause the Work to be done at their Expense.

No. 126. LXXXI.—After the Commencement of this Act it shall not be lawful newly to erect any House, or to rebuild any House pulled down to the Extent aforesaid, within any Parish mentioned in Schedule (A.) to this Act, or any District mentioned in Schedule (B.) to this Act, without a sufficient Watercloset or Privy and Ashpit furnished with proper Doors and Coverings, and also furnished as regards the Watercloset with suitable Water Supply and Water Supply Apparatus, and with suitable trapped Soilpan and other suitable Works and Arrangements, so far as may be necessary to ensure the efficient Operation thereof; and whosoever shall offend against this Enactment shall be liable to a Penalty not exceeding Twenty Pounds; and if at any Time it appear to the Vestry or District Board of such Parish or District that any House in any such Parish or District, whether built before or after the Commencement of this Act, is without a sufficient Watercloset or Privy and Ashpit furnished with proper Doors and Coverings, and with other Apparatus and Works as aforesaid, the Vestry or District Board shall, in case the same can be provided without disturbing any Building, give Notice in Writing to the Owner or Occupier of such House, requiring him forthwith, or within such reasonable time as shall be specified in such Notice, to provide a sufficient Watercloset or Privy and Ashpit so furnished as aforesaid, or either of them, as the Case may require; and if such Notice be not complied with it shall be lawful for the Vestry or District Board to cause to be constructed a sufficient Watercloset or Privy and Ashpit, or either of them, or do such other Works as the case may require, and to recover the Expenses incurred by them in so doing from the owner of such House in manner herein-after provided: Provided always, that where a Watercloset or Privy has been and is used in common by the Inmates of Two or more Houses, or if in the Opinion of the Vestry or District Board a Watercloset or Privy may be so used, they need not require the same to be provided for each House.

Power for Vestries and District Boards to authorize Inspection of Drains, Privies, and Cesspools.

No. 127. LXXXII.—It shall be lawful for any such Vestry or Board, or for their Surveyor or Inspector, or such other Person as they appoint, to inspect any Drain, Watercloset, Privy, Cesspool, or Water Supply Apparatus, or Sinks, Traps, Siphons, Pipes, or other Works or Apparatus connected therewith, within the Parish or District of such Vestry or Board, and for that Purpose, at all reasonable Times in the Daytime, after Twenty-four Hours' Notice in Writing has been given to the Occupier of the Premises to which such Drain, Watercloset, Privy, Cesspool, or Water Supply Apparatus, or other connected Works or Apparatus as aforesaid, is attached, or left upon the Premises, or in case of Emergency without Notice, to enter, by themselves or their Surveyor or Inspector and Workmen, upon any Premises, and cause the Ground to be opened in any Place they think fit, doing as little Damage as may be.

Penalty on Persons improperly making or altering Drains.

No. 128. LXXXIII.—In case any Drain, Watercloset, Privy, Cesspool, or Water Supply, or Water Supply Apparatus, or other connected Works or Apparatus, hereinbefore mentioned, be found, on Inspection, not to have been made or provided according to the Directions or Regulations of the Vestry or District Board, or contrary to the Provisions of this Act, or in case any Person, without the Consent of the Vestry or District Board, construct, rebuild, or unstop any Sewer, Drain, Watercloset, Privy, or Cesspool which may have been ordered by them not to be made, or to be demolished or stopped up, or in case any Person discontinue any Water Supply, or destroy any connected Works or Apparatus as aforesaid, or in case any Person, without the Consent of the Vestry or District Board, break into any Sewer vested in such Vestry or Board, every Person so offending shall forfeit and pay any Sum not exceeding Ten Pounds; and in case the Person so making any Sewer, Drain, Watercloset, Privy, Cesspool, or other Works or Apparatus as aforesaid, contrary to the Directions or Regulations of the Vestry or Board, or contrary to the Provisions of this Act, or, without such Consent as aforesaid, constructing, rebuilding, or unstopping any Sewer, Drain, Watercloset, Privy, or Cesspool which may have been ordered to be demolished or stopped up, or discontinuing any Water Supply, or destroying any connected Works or Apparatus as aforesaid, or breaking into any such Sewer as aforesaid, do not, within Fourteen Days after Notice in Writing by the Vestry or Board, cause such Sewer, Drain, Watercloset, Privy, or Cesspool to be altered or reinstated in conformity with the Directions of the Vestry or Board, or, as the Case may be, to be demolished or stopped up, or such Water Supply to be renewed, or such connected Works or Apparatus to be restored, then, and in every such Case, the Vestry or Board

may cause the Work to be done, and the Expenses thereof shall be paid by the Person who has so offended.

Where no Default found Expenses to be paid by Vestry or Board.

No. 129. LXXXIV.—If such Drain, Watercloset, Privy, Cesspool, or Water Supply, or Water Supply Apparatus, or other connected Works and Apparatus, be found on Inspection as aforesaid, to be made to the Satisfaction of the Vestry or Board, and in proper Order and Condition, they shall cause the same to be reinstated and made good as soon as may be, and the Expenses of Examination, reinstating, and making good such Drain, Watercloset, Privy, Cesspool, or other Works or Apparatus as aforesaid, shall be defrayed by the Vestry or Board, and full Compensation shall be made by them for all Damages or Injuries done or occasioned by the Examination of any such Drain, Watercloset, Privy, Cesspool, or other Works or Apparatus as aforesaid.

Vestry or District Board to cause Drains, &c., to be put into proper Condition, &c., where necessary.

No. 130. LXXXV.—If, upon such Inspection as aforesaid, any Drain, Watercloset, Privy, or Cesspool appear to be in bad Order and Condition, or to require Cleansing, Alteration, or Amendment, or to be filled up, the Vestry or Board shall cause Notice in Writing to be given to the Owner or Occupier of the Premises upon or in respect of which the Inspection was made, requiring him forthwith, or within such reasonable Time as shall be specified in such Notice, to do the necessary Works; and if such Notice be not complied with by the Person to whom it is given, the Vestry or Board may, if they think fit, execute such Works, and the Expenses incurred by them in so doing shall be paid to them by the Owner or Occupier of the Premises.

Vestry and District Board to cause offensive Ditches, Drains, &c., to be cleansed or covered. Where Works interfere with any Ancient Mill, &c., Compensation to be made, or Rights therein purchased.

No. 131. LXXXVI.—Every Vestry and District Board shall drain, cleanse, cover, or fill up, or cause to be drained, cleansed, covered, or filled up, all Ponds, Pools, open Ditches, Sewers, Drains, and Places containing or used for the Collection of any Drainage, Filth, Water, Matter, or Thing of an offensive Nature, or likely to be prejudicial to Health, which may be situate in their Parish or District; and they shall cause written Notice to be given to the Person causing any such Nuisance, or to the Owner or Occupier of any Premises whereon the same exists, requiring him, within a Time to be specified in such Notice, to drain, cleanse, cover, or fill up such Pond, Pool, Ditch, Sewer, Drain, or Place, or to construct a proper Sewer or Drain for the Discharge of such Filth, Water, Matter, or Thing, or to do such other Works as the Case may require; and if the Person to whom such Notice is given fail to comply therewith, the Vestry or Board shall execute such Works as may be necessary for the Abatement of such Nuisance, and may recover the Expenses thereby incurred from the Owner of the Premises in manner herein-after mentioned: Provided always, that it shall be lawful for such Vestry or Board, where they think it reasonable, to defray all or any Portion of such Expenses, as Expenses of Sewerage are to be defrayed under this Act: Provided also, that where any Work by any Vestry or District Board done or required to be done in pursuance of the Provisions of this Act interferes with or prejudicially affects any ancient Mill, or any Right connected therewith, or other Right to the Use of Water, full Compensation shall be made to all Persons sustaining Damage thereby, in manner herein-after provided, or it shall be lawful for the Vestry or Board, if they think fit, to contract for the Purchase of such Mill, or any such Right connected therewith, or other Right to the Use of Water; and the Provisions of this Act with respect to the Purchases by the Vestry or Board herein-after authorized shall be applicable to every such Purchase as aforesaid.

Owner of Courts to Drain them, and Keep the Pavement, &c., in repair. Penalty on Owners for Neglect.

No. 132. C.—The Owner of any such Court, Passage, or public Place, not being a Thoroughfare, shall, if required by the Vestry or District Board of the Parish or District in which the same is situate, to the Satisfaction of such Vestry or District Board, sufficiently pave, cover the Surface of, or repair the same, and lay, at a proper Level through, over, under, or along such Part thereof as such Vestry or Board may require, a Drain, Channel, or Gutter, and keep such Pavement or Covering, and Drain, Channel, or Gutter, in good Repair, to the Satisfaction of such Vestry or Board; and if any such Owner of any Court, Passage, or public Place, not being a Thoroughfare, do not sufficiently pave or cover the same as aforesaid, or do not lay down therein such Drain, Channel, or Gutter, or do not repair the same respectively, to the Satisfaction of such Vestry or Board, within Fourteen Days after Notice in Writing requiring him so to do has been given to him by such Vestry or Board, every such Person so offending shall forfeit and pay any Sum not exceeding Five Pounds. [See 81, of the Act 1862, No. 142.]

Notice to be given by Companies to Vestries and District Boards when Pavement, &c., is required to be taken up.

No. 133. CIX.—No Company or Person shall break up or open the Pavement, Surface, or Soil of any Street, the paving whereof is under the Control and Management of the Vestry or District Board of any Parish or District, for the Purpose of making and laying down any Main of Pipes, or for any other Purpose whatsoever, except in Cases of Emergency arising from Defects in Pipes or other Works, without having previously given Three clear Days' Notice in Writing to such Vestry or District Board, stating in such Notice the Name of the Street and the particular Part thereof in which such Pavement, Surface, or Soil is intended to be broken up or opened, the Day on which the Work is proposed to be commenced, and the Time within which it will be completed; and in any such Case of Emergency as aforesaid such Company or Person shall, within Twelve Hours after they or he begin to break up or open such Pavement, Surface, or Soil as aforesaid, give such Notice as aforesaid to the said Vestry or District Board; and no such Pavement, Soil, or Surface shall be broken up or opened for the Purpose of laying down any new Main of Pipes for the Conveyance of Water during any Part of the Months of *December*, *January*, and *February*, without the Consent of the said Vestry or District Board; and no Gaslight Company shall at any time break up or open any such Pavement, Surface, or Soil for the Purpose of laying down any new Mains of Pipes, without the Consent in Writing of the said Vestry or District Board; and every Company or Person offending against this Enactment shall for every such Offence forfeit a Sum not exceeding Five Pounds, and shall within Twenty-four Hours after Notice in Writing

from the Vestry or District Board, cause such Mains or Pipes to be taken up and removed, and the Pavement, Surface, or Soil to be reinstated and put into its former State: Provided always, that any Gaslight Company may break up or open any such Pavement, Surface, or Soil, for the Purpose of laying down and attaching to Mains and Pipes already existing any new Service Pipes, on giving to the said Vestry or District Board, Three Days at the least before so doing, Notice of their Intention to break up or open such Pavement, Surface, or Soil for such purpose.

Streets not to be broken up, except under the Superintendence of Vestry or Board. Streets broken up to be reinstated without delay.

No. 134. CX.—Whenever it is necessary, from any Cause whatever, for any Company or Person to break up or open the Pavement, Surface, or Soil of any Street, such Street and the Pavement, Surface, and Soil thereof, shall be broken up and opened under the Superintendence of the Vestry or District Board of the Parish or District in which the same is situate, and in such Manner, and as regards Gas Companies at such time, as they shall direct; and such Company or Person shall with all convenient Speed complete the Work on account of which the same is broken up or opened, and fill in the Ground and make good the Pavement or Surface or Soil so broken up or opened, and carry away the Rubbish occasioned thereby, and shall in the meantime cause the Place where such Pavement or Surface or Soil is so broken up or opened to be fenced and guarded, and shall set up and maintain upon or against the Part of the Pavement, Surface, or Soil so broken up or opened a sufficient Light during every Night that such Pavement or Surface or Soil is continued open or broken up.

Penalty on Persons taking up Pavements neglecting to reinstate them, and to place Lights during the Night time to prevent Accidents.

No. 135. CXI.—If any Company or Person authorised to break up or open any of the Pavement or Surface of any Street, for the Purpose of laying, altering, or repairing any Gas, Water, or other Pipe, or other lawful Cause, do not with due Diligence cause the Ground to be filled in, and the Pavement to be reinstated, and the Surface to be made good, in a proper and substantial Manner, or do not in the meantime fence and guard the same, and affix and maintain Lights during the Night near to the Places where any Ground is open, so as to prevent any Accident, every such Company or other Person so offending shall for every such Offence forfeit a Sum not exceeding Five Pounds, and also a further Sum not exceeding Forty Shillings for every Day during which such Offence continues; and no such Pavement shall be considered to have been reinstated in a proper and substantial Manner by any such Company or other Person unless the same have been reinstated with the same or similar Materials of the like Quality and Thickness, and cemented and bound together in the same or in an equally substantial Manner, as those of which it was composed, in such Manner as is satisfactory to the Vestry or Board.

No. 136. What is a Drain under the Metropolis Local Management Act, 14th August, 1855?

Section 250 says: "The word 'drain' shall mean and include any drain of and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed, and shall also include any drain for draining any group or block of houses by a combined operation under the order of any vestry or district board."

The Metropolis Local Management Act of 1862, Section 112, also interprets the meaning as follows:—

"The word 'drain' shall be deemed to apply to and include the subject matters specified in the 250th Section of the firstly-recited Act, and also any drain for draining a group or block of houses by a combined operation, laid or constructed before the first of January, 1856, pursuant to the order or direction or with the sanction or approval of the Metropolitan Commissioners of Sewers."

There is a small Act intituled "An Act to amend the Act of the last Session of Parliament, chapter one hundred and twenty, for the Better Local Management of the Metropolis (29th July, 1856), but nothing of any interest to the plumber.

Then follows this Act of 1862:—

ANNO VICESIMO QUINTO AND VICESIMO SEXTO
VICTORIÆ REGINÆ.

CAP. CII.

An Act to amend the Metropolis Local Management Acts. [*7th August*, 1862.]

Private Parties before branching Sewers into Main or District Sewers to apply for Sanction of Vestries, &c.

No. 137. 47.—Every Person other than a Vestry or District Board intending to make or branch a Sewer, either into a Sewer vested in the Metropolitan Board of Works, or into a Sewer vested in any Vestry or District Board, shall in the first instance lay the Plan and Section thereof before, and apply for the Sanction of, the Vestry or District Board of the Parish, District, or Part in which such last-mentioned Sewers shall be situate; and no Sewer shall

be begun to be made by such Person until the Sanction in Writing of such Vestry or District Board shall have been obtained.

Seven Days' Notice must be given before Drains can be branched into Main Sewers.

No. 138. **49.**—All Persons intending to make or branch any Drain into a Sewer vested in the Metropolitan Board of Works shall, Seven clear Days before commencing any Works for that Purpose, make written Application to the Vestry or Board of the Parish, District, or Part in which such Sewer shall be situate, accompanied by a Plan showing such Particulars as may be required by any Byelaw or Resolution of the said Metropolitan Board; and no such Work shall be commenced until the Sanction in Writing of the said Vestry or District Board shall have been given.

Temporary Provision for Drainage of Property where no proper Sewer within 200 Feet.

No. 139. **66.**—Whereas certain property within the Limits of the Metropolis is so situate as to render it impracticable, or practicable only at undue Expense, to connect such Property with covered Sewers, and it is expedient that some temporary Provision should be made for draining such Property and abating the Nuisances existing thereon or caused thereby; Be it therefore enacted, That in any Case in which any House or other Building, whether erected before or after the passing of this Act, is without sufficient Drainage, and there is no proper Sewer within Two Hundred Feet of any Part of such House or Building, it shall be lawful for the Vestry or District Board of the Parish or District in which such House or Building is situate by Notice in Writing to require the Owner of such House or Building to construct and lay from such House or Building a covered Drain to lead therefrom into a covered water-tight Cesspool or Tank or other suitable Receptacle, not being under a House or within such Distance from a House as the Vestry or Board shall direct, and to construct such Cesspool, Tank, or Receptacle; and the several Provisions in the firstly-recited Act with respect to the laying of House Drains at the Expense of the Owners of Property, and the Recovery of such Expenses of and the Penalties for any Omission in respect to the Performance of any such Works pursuant to the orders of Vestries or District Boards in accordance with the Directions of the said Act, shall be extended to and apply to the making of such Cesspools, Tanks, Receptacles, and Drains, and the Orders of Vestries and District Boards in relation thereto and the Expenses thereof.

Vestries, &c., may compel Supply of Water for Houses.

No. 140. **67.**—If it shall appear to any Vestry or District Board that any House within their respective Parishes or Districts is without a proper Supply of Water, and that such Supply can be furnished to such House at a Rate not exceeding Threepence *per* Week, conformably with the Scale of Rates authorised to be charged by any Water Company within the Metropolis as defined by the firstly-recited Act, the said Vestry or District Board may give Notice in Writing to the Owner or Occupier of such House, requiring him, within a Time specified therein, to obtain such Supply, and to do all such Works as may be necessary for that Purpose; and if such Notice be not complied with the said Vestry or District Board shall do such Works and recover the Expenses thereof from the Owner of the Premises as hereinafter provided; and any Water Company shall, upon the Requisition of such Vestry or Board, supply with Water such House, and the Rates for the Supply of such House or Houses as aforesaid shall be due and payable by the said Owner, and shall be recovered by the Company as if such Owner had contracted with the Company for the Supply of such Water. In any Case where it shall appear to any Vestry or District Board that the existing Supply of Water to any House within their respective Parishes or Districts would be sufficient for such House if the same were inhabited by a lesser Number of Persons, but is insufficient by reason that the same is inhabited by numerous Persons (being more than One single Family), it shall be lawful for such Vestry or District Board to give Notice in Writing to the Occupier of such House, requiring him, within a Time specified therein, to obtain such further Supply (not exceeding a Supply at the Rate of Thirty Gallons *per* Day for each Person) as to them shall appear necessary, and to do all such Works as may be necessary for that Purpose; and if such Notice be not complied with within the Time therein specified, it shall be lawful to take Proceedings for overcrowding, in the Manner Provided by the "Nuisances Removal Act for *England*, 1855"; and upon Proof of the Fact that the Water Supply is not sufficient by reason of the Number of Persons inhabiting the said House (being more than One Family) it shall be lawful for the Justices to make the like Order and to inflict the like Penalty as in any other Case of overcrowding.

Penalty on Persons interfering with Sewers

No. 141. **69.**—Any Person who shall take up, remove, demolish, or otherwise interfere with any Sewer or Part of a Sewer vested in the Metropolitan Board of Works, or in any Vestry or District Board, without the previous Permission in Writing of such Board or Vestry, or who shall wilfully damage any Sewer, Bank, Defence, Wall, Penstock Grating, Gully, Side Entrance, Tide Valve, Flap, Work, or Thing vested in the Metropolitan Board or any Vestry or District Board, or do any Act by which the Drainage of the Metropolis or any Part thereof may be obstructed or injured, shall for every such Offence forfeit and pay to the said Metropolitan Board of Works, or to the Vestry or District Board aggrieved by any such Act, for every such Offence a Sum not exceeding Twenty Pounds, and shall also pay to such Board or Vestry all Expenses of repairing, restoring, reinstating, or amending any Sewer or other Work or Thing so taken up, removed, demolished, damaged, or interfered with, to be recovered by Action at Law or before a Justice of the Peace by a Summary Proceeding, at the Option of the Board or Vestry.

Where Owners of Courts, &c., omit to drain and pave, Vestry or District Board may perform the Works, charging Expenses to Owner.

No. 142. **81.**—In any Case of Default by the Owner of any Court, Passage, or Public Place, not being a Thoroughfare, to comply with the Requisition of any Vestry or District Board to perform Works of paving or draining of the Nature described in the One hundredth Section of the firstly-recited Act, it shall be lawful for the Vestry or Board, should they see fit, in lieu of enforcing the Penalty therein mentioned, to execute and perform such Works, and recover the Expenses thereof from the Owner, either by Action at Law or in a summary Manner before a Justice, at the Option of the Vestry or Board.

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Penalty for keeping Swine in improper Situations.

No. 143. **91**.—No Person within any Parish mentioned in Schedule A (this gives a list of Parishes for about eight miles round London, it extends to Hampstead, Fulham, Greenwich District, Wandsworth, Hackney District, Woolwich, Paddington, Kensington, Camberwell, Chelsea, Rotherhithe, Clapham, Hatcham, Tooting, Graveny, Streatham, Putney, and Roehampton, Stoke Newington, &c.), to the firstly-recited Act, or in any District mentioned in Schedule B to the said Act, shall breed, feed, or keep any Swine in any Locality, Premises, or Place which may be unfit for the keeping of Swine, or in which the breeding, feeding, or keeping Swine may create a Nuisance, or be injurious to Health; and any Person breeding, feeding, or keeping Swine in or on any such Locality, Premises, or Place shall be liable to a Penalty not exceeding Forty Shillings, and to a further Penalty not exceeding Ten Shillings for every Day during which he shall continue such Offence after notice from the Vestry or District Board to discontinue the same, and any such Penalty may be recovered by a summary Proceeding; and if in any proceeding under this Enactment it shall be proved to the Satisfaction of the Justice or Justices that any such Locality, Premises, or Place are or is unfit for the keeping of Swine, such Justice or Justices may prohibit the using thereof for that purpose for the future; and any Person disobeying the Order of any Justice or Justices in this Behalf shall be liable to a Penalty of Ten Shillings for every Day during such his Default.

Licensing Cowhouses.

No. 144. **93**.—From and after the First Day of *November* One thousand eight hundred and sixty-two, no Place within any Parish or Place mentioned in the Schedules to the firstly-recited Act shall be used by any Person carrying on the Business of a Slaughterer of Cattle or Cowkeeper or Dairyman as a slaughter-house for the Purpose of slaughtering Cattle or a Cowhouse or Place for the keeping of Cows, without a Licence had for such Purpose respectively from the Justices of the Peace assembled at a Special Sessions held in the Division or District where such Slaughter-house, Cowhouse, or Place is situate, and such Licence shall continue in force for the Period of One Year from the granting thereof, and thenceforth until the Special Sessions to be held next after the Expiration of such Period, and no Fee or Reward exceeding Five Shillings shall be taken for any such Licence; and if any Person carrying on such Business of a Slaughterer of Cattle, Cowkeeper, or Dairyman use as a Slaughter-house or Cowhouse any Place within any Parish or Place mentioned in the Schedules of the firstly-recited Act which is not so licensed, every Person so offending shall for each Offence be liable to a Penalty not exceeding Five Pounds, of which Offence the Fact that Cattle have been taken into such Place shall be deemed sufficient *primâ facie* Evidence: Provided always, that before any Licence for the Use of any Place as a Slaughter-house or Cowhouse is granted as aforesaid, Fourteen Days' Notice of the Intention to apply for such Licence shall be given to the Vestry or District Board of the Parish or District in which any such Place is situate, to the Intent that such Vestry or District Board, if they think fit, may show cause against the granting of any such Licence, and also Seven Days' Notice previous to such Special Sessions being held of the Intention to apply for such Licence shall be given to the Clerk of the Justices for such Division: Provided, that nothing in this Act contained shall extend to Slaughter-houses erected or to be erected in the Metropolitan Cattle Market under the Authority of the Metropolitan Market Act, 1851, or the Metropolitan Market Act, 1857.

Month's Notice to be given of applying for Licence for keeping Slaughter-house.

No. 145. **94**.—Before any Licence for the keeping or using of any House or Place within the Metropolitan Police District as a Licensed Slaughtering House or Place for the Purpose of slaughtering or killing Horses or other Cattle not killed for Butchers' Meat shall be granted by any Quarter Sessions of the Peace under the Provisions of the Act of the Session holden in the Twenty-sixth Year of the Reign of His Majesty King *George* the Third, Chapter Seventy-one, or of the Act of the Session holden in the Seventh and Eighth Years of Her present Majesty, Chapter Eighty-seven, or any Act amending either of the said Acts, One Month's previous Notice of the Intention to apply for such Licence shall be given to the Vestry or District Board of the Parish or District in which such House or Place is situate, to the Intent that such Vestry or District Board, if they think fit, may show cause against the Grant of such Licence.

No. 146.—What is a NUISANCE?

(Nuisance Removal Act of 14th August, 1855.)

This Act in Clause VIII. sets out what is to be considered a Nuisance as follows:

"The word Nuisance under the Act shall include any premises in such a state as to be a nuisance and injurious to health:—

"Any pool, ditch, gutter, watercourse, privy, urinal, cesspool, drain or ashpit so *foul* as to be a nuisance or injurious to health."

Who may give Notices of a NUISANCE?

It sets forth in Clause X. of the above Act as follows:

"Notice of Nuisance may given to the Local Authority by any person so aggrieved thereby, or by the following persons: the Sanitary Inspector, or any paid Officer under the said Local Authority, &c., &c."

Clause XII. gives authority to Justices of the Peace to issue orders for the abatement of the nuisance, and Clause XIII. gives the Justices power to make orders for works necessary to prevent a future nuisance originating from the same cause, and to be done in a given time; and Clause XIV. gives the Justices power to inflict a penalty for non-attention to their order, with power to enter and remove or abate such nuisance.

LEAD LIGHT AND STAINED GLASS GLAZING.

In order that my work may be a little varied and interesting to both town and country workmen, I shall close this volume with a chapter on Lead Light Glazing, a subject which will be very interesting to the country workmen, more especially as it is a subject yet without its literature, excepting that which I have written for trade journals.

We have now come to that part of our work known as Lead Light Glazing, which every country plumber should be well grounded in, as it is very handy to fill up time, and for a change of work; besides, the work originated with the plumbers, painters, and glaziers.

To begin with, I will assume that you have a good diamond, or two, one for rough, and the other for light work; also, that you have a rule and straightedge, and that you have settled upon what shape your light is to be. The setting out will be shown as you proceed. Every kind of glass may be had from the glass merchant's, and therefore this we shall not say much about until the proper time arrives. The Diamond is shown at Fig. 672.

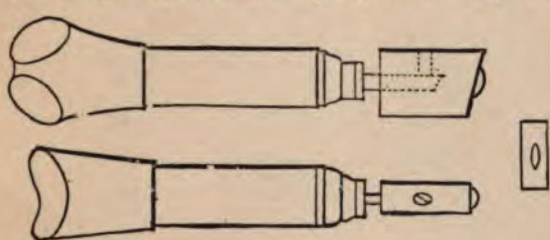


FIG. 672.

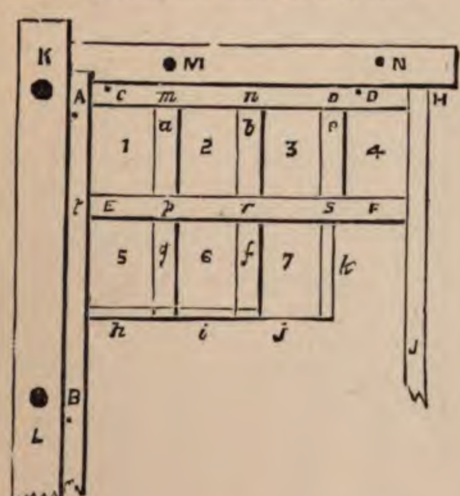


FIG. 673.

Having chosen the size window lead and quality of glass to be used, proceed to make an ordinary square lead light. For the method of work refer to Fig. 673. First you require a full-sized drawing of the window, or you must set your light out on a board, or on the bench, to the exact shape and size required, showing all the lead work, allowing for the thicknesses of the lead; then, if it is for a square window, fix the lath K L, Fig. 673, also the lath M N square to K L. Now, having all lined out, take the lead, or calme, and place one end under the foot, and with the other end pull it so as to stretch it out quite straight; then fix the calme as at A B, with shoemakers' sprigs, or brads about $\frac{1}{2}$in. to $\frac{3}{4}$in. long, and as shown at the dots near A and B.

The Ladkin, or Ladakin.

Next, with a ladakin, Fig. 674. This is a small piece of box-wood or bone, about 5in. or 6in. long, 1in. wide, $\frac{3}{8}$in. thick, with the sides tapered, rounding from point to $\frac{1}{2}$in. up the sides for opening the calmes. Open the sides of the calme as shown at Fig. 674, also as shown at A, Fig. 675

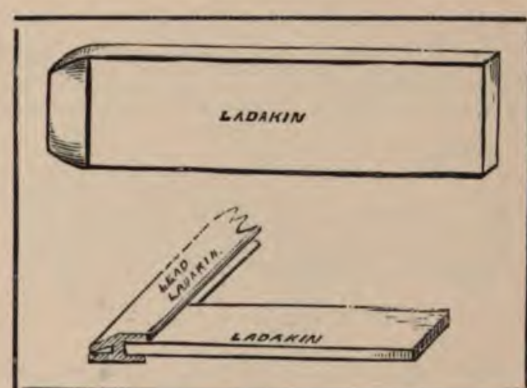


FIG. 674.

The ladakin is a tool which requires to be held so that it will give to the hand, in order that it may open the calmes without causing them to rivel. Another important point is to keep this tool nearly square with the calme, or, if anything, lean the end D, Fig. 675, a little from D towards B, for, should you bring the point A before D, the chances are that the point will slip out of the calme, thereby opening the sides unevenly.

Now stretch another length, and see that the end is quite bright and clean. Next fix the end C in A, as shown at A, Fig. 673. Sprig this calme down as at C D. Next you require the first square of glass, 1. This being cut, next with the ladakin, open the sides of the calme, A B and C D, and fix the square as shown at 1. Now, for argument sake, let us fix the first row of squares along the top, as at 1, 2, 3, 4, which is done as follows, but first you want a cutting knife.

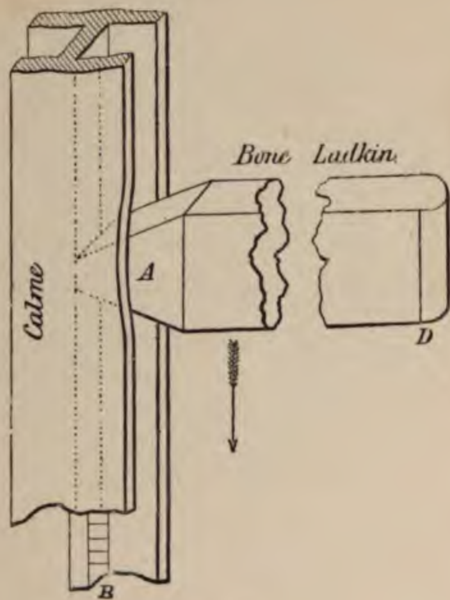


Fig. 675.

The Cutting Knife.

This is simply a piece of steel having a rounded, shaped sharp cutting edge, as from B to C, Fig. 676, and a bone handle, with a knob A for the palm of the hand to press on,

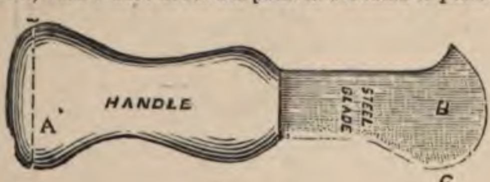


Fig. 676

or sometimes the shape of the knife is as at Fig. 677. This is known as a closing or setting, and cutting knife combined. It is simply the knife blade as in Fig. 676 with a different handle; this handle has a lump of solder at the end, as at A, which answers to drive or knock the squares up to their place in the calmes, it also answers to drive brads occasionally, etc., etc. Now refer to Fig. 673.

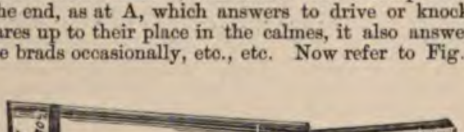


Fig. 677.

Having No. 1 square set, with your cutting knife cut the piece of lead *a*, to the exact length of the square 1, and with the ladakin open its sides; then see that the end is right; now place it into the end calme at *m*, and over the edge of the first square of glass, as shown at *a*. Next place the No. 2 square in the lead *a m*, and with the end of your setting knife at A, Fig. 677, gently knock the edges of the square, so as to force them well home and into

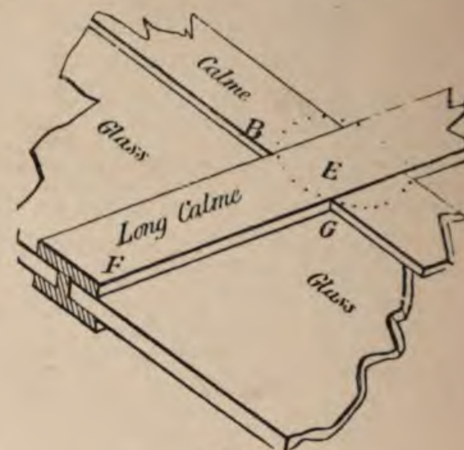


Fig. 678.

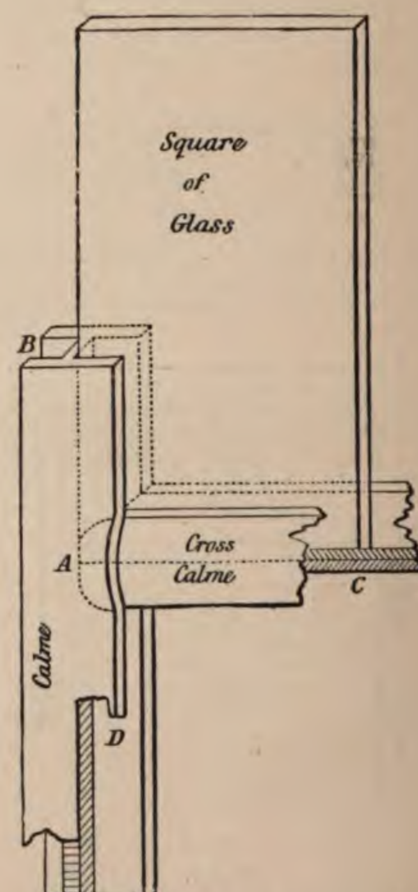


Fig. 679

the leads, as shown at F, Fig. 678, also at A B C, Fig. 679. Next cut another piece of lead, *b*, Fig. 673, the exact length (see that its end is clean and bright), and place this in the end lead at *n*, and as you did lead *a*; next place square 3 and lead *e*, and next square 4, knock them all up tight together. Now you have one row of squares set.

Glass Cutting Gauge.

If you have many squares in your light, you should cut them in a gauge as shown at Fig. 680, which is made by nailing two laths on the bench, and setting four 2in. or 3in. nails (as at NAIL and GAUGE NAILS) to the exact distance

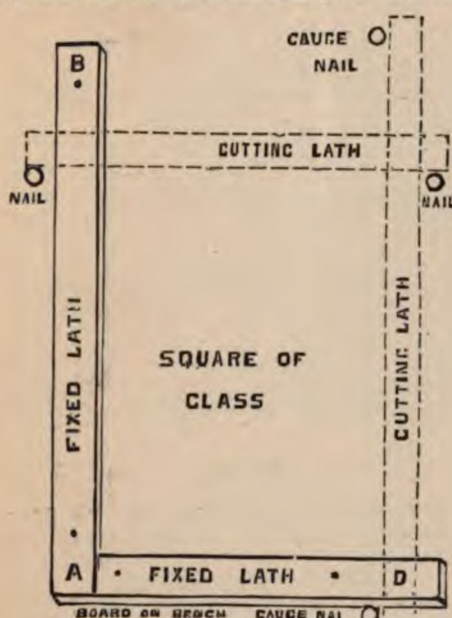


FIG. 680.

for the straight edge to rest against whilst the glass is being cut. The next thing wanted is the cross calme, or lead, for fixing as at E F, Fig. 673, and for holding the ends of the leads *a b e*; this cross calme is also shown fixed into the side calme, as at *Cross Calme*, Fig. 679. Now having the end cut, as shown by the dotted lines, clean it; then with your ladakin open the side, as at LEAD LADAKIN, Fig. 674, etc., and place the lead over the ends of the squares, and ends of the lead *a*, *b*, *e*, as at *p*, *r*, *s*, and next proceed with another row of squares, as at 5, 6, 7; or, instead of first fixing the row of squares as at 1, 2, 3, 4, you may find it more convenient to fix your first row up the side, as at 1, 5, etc. This will at times depend upon the length of your calmes, and if done in this latter way, then the short leads of course will have to be across the light. Having worked the required quantity of glass in, and all the lead worked down smooth, as at F G B and C, Fig. 678, fix the end calme opposite the end C D, Fig. 673, and then the side calme H J.

Soldering up Lead Lights.

Having everything right, next is the soldering. This is done as follows: First you require the soldering iron; this is illustrated at Fig. 681. It is simply an iron with a pointed end, and having a tinned point; the size is usually about

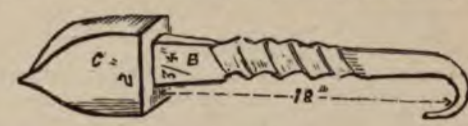


FIG. 681.

2in. by 2in., with a handle 18in. long with gripping twist as shown. This is for the purpose of forming a good grip with the felt, or holder, or hand sticks (two sticks hollowed out to clip the handle instead of felt). Instead of the iron soldering iron, some glaziers use the ordinary straight copper bit, and for my part, I very much prefer the copper bit, though it requires practice not to burn the lead with this tool. The iron does not give its heat so readily up to the lead. Now suppose everything to be ready for soldering, next take a strip of fine solder in the left hand, and with your resin box, Fig. 53, sprinkle a little *black* resin on the joint and apply the solder and iron in the usual manner; *but don't allow it to be too hot*, nor stay too long on the joint, or it will nip the lead. Put sufficient solder on to form a nice clean raised round button, and in this manner solder each joint. (Some plumbers use killed spirits instead of resin because it makes cleaner work, but the resin is the best, for it forms a cement between the leads and the glass.) Now turn the light over and solder the other side.

Ties or Bands.

These ties are simply bits of lead or copper wire, the latter being generally used in fret-work work (stained glass or ornamental work), and soldered on at the joints as shown at *Solder*, Fig. 682, and in such a manner that it

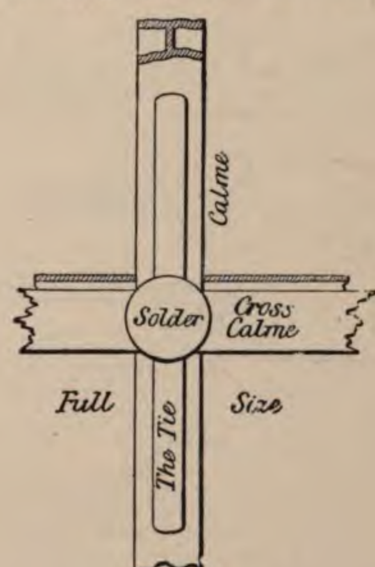


FIG. 682.

will hold the light to the window bars, which bars are generally about ⅜in. diameter, and placed to suit the cross leads. These bars are shown at A C B, Fig. 710, or sometimes, as in the very old houses, the bars are placed in

an upright position. The ties are soldered on at su•h places as the workman may think necessary for supporting the light.

Cementing.

The cementing is for the purpose of keeping the glass firm together in the lead, it also makes the work stronger, and keeps it more water and wind tight. It is done as follows: With an old paint tool and some good stiff lead colour paint, rub the leads and joints all round with the paint. Now get some whitening and a black lead brush, rub the whitening into the joints of the lead work; keep at this until the glass and joint appear free from the paint; or instead of whitening, wood ashes may be used, which will set very hard. Next, clear all the whitening off, and with some lamp black strewed all over the light, with your black lead brush rub away over the joints until they shine like a black-leaded stove, and the glass is perfectly free from grease. Then clean off, and the light is finished ready for fixing.

It is quite possible that after the cementing work is done, that you will find the cementing run, viz. :—there has been too much paint used, owing to the bad work. For instance, should your closing be defective the paint will too readily get into the calmes; again, should your glass be "wobbley," the paint will be worked down between the edge of the glass and the backs of the calmes, and not only will the work be bad, but the cementing will take three times as long to do. This bad work is often due to the slovenly manner in which the calmes are opened. Another thing is very important: that is, the sides should be well rubbed down quite straight, smooth, and true, so as to fit the glass as shown at F G B, &c., Fig. 678. There is another important point to be kept in view. When cutting the ends of the cross calmes to enter the side calme, cut the end of the cross calme as shown by the dotted line at A, Fig. 679. This allows the side calme to be worked down more neatly.

Fixing the Light.

The next thing to do is to fix the light, say, into a square opening, having the rabbets properly prepared to receive them. These rabbets are generally sunk into the

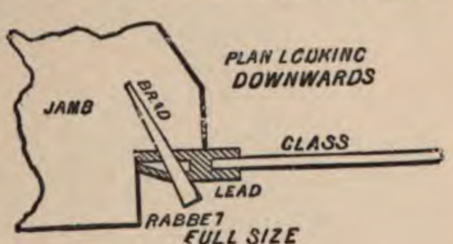


Fig. 683.

jambs, lintel, and sills, about ½in. deep, and from ¼in. to ½in. wide, as shown in the plan at RABBET, Fig. 683.

Having everything ready, let us assume that it is just the size; let 1, 2, 3, 4, Fig. 684, be the wood frame, having the above-mentioned sunk rabbet of about ½in. deep all round the inside, but on the external side of the frame at 5, 6, 7, 8, 9, &c. Now having your *Tie* bars fixed into the sides of the frame as at A C B, Fig. 710, and as at *Tie*, Fig. 684, and your ties laid flat as shown at *Tie*, Fig. 682, put the light into the bottom part of the frame, and lift the top part into its position. Let someone be inside to turn and fasten the ties round the tie bar, as at *Tie*, Fig. 684. The ends of the ties should be twisted

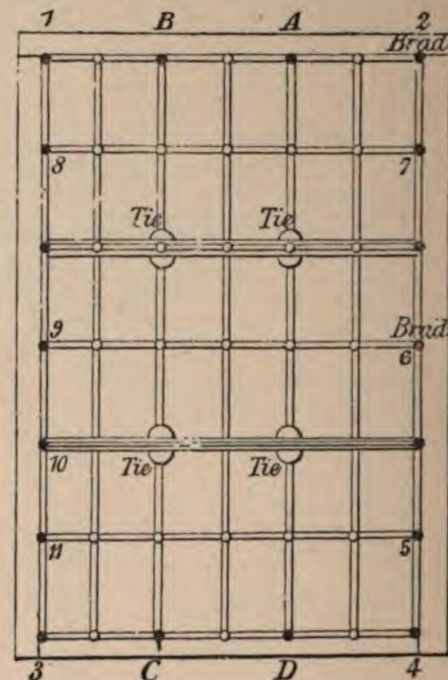


Fig. 684.

round as shown at *Lead Tie*, Fig. 685. For this purpose you must have a pair of cutting pliers as shown at

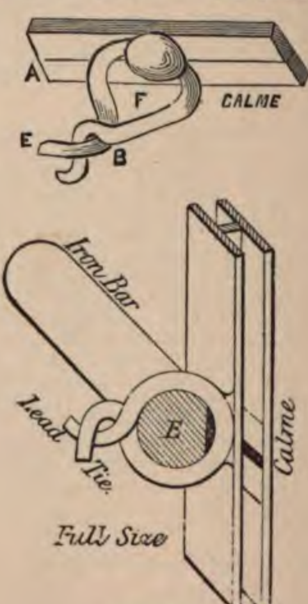


Fig. 685.

Fig. 686. B is the knife or cutting edge, and A is the straight, flat, and narrow teeth edge, from $\frac{1}{4}$in. to $\frac{3}{8}$in. long,

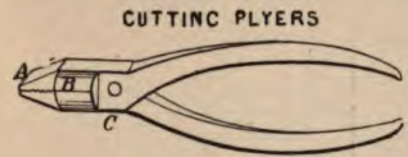


FIG. 686.

and $\frac{1}{4}$in.wide, for twisting the ends of the ties. Having with the pliers twisted the tie as shown at *Tie*, Fig. 685, with the pliers cut the ends of the tie off true one with the other, and in such a manner that children cannot *untwist them*. Sometimes the tie bars are fixed lengthways with the window, when the tie must be put on as at A F E B, Fig. 685. Now having the ties tied, take a few $\frac{3}{4}$in. brads, such as shoemakers use, and nail the outside of the calmes to the frame, put the brads in sideways, and at the joints as shown at BRAD in the plan, Fig. 683, and by the dots I B A, 2, 5, 6, 7, 8, 9, 10, &c., Fig. 684. Now suppose your lead light to be a little too large, sometimes you may get over the difficulty by cutting away a little of the rabbet; at other times you will have to cut off the outside calme, and cut down the glass. Should it be much too large, say $\frac{3}{4}$in.; cut off both sides, and equalize it accordingly; but suppose the light to be too small, then the difficulty is often to be got over by fixing another calme over the

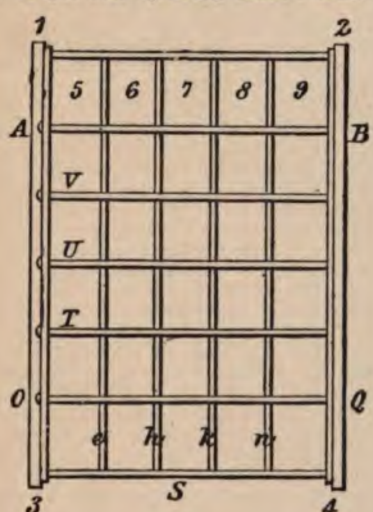


FIG. 687.

outer, as shown at A 3, Q 2, Fig. 687. I have fixed as many as two calmes, one over the other. Should the mistake be too great to be rectified with the thickness of two calmes, then it is often to be got over by fixing a border as shown at A, B, 7, 1, &c., Fig. 690.

Casement Lights.

Should the light be for fixing to a lead light frame, or casement, then $\frac{1}{4}$in. holes are drilled, one at each corner, and at every 6in. or 9in. round the outside of the frame, and opposite each joint of the outside calmes.

Here you will require bits of band to tie the light on to the frame. Now, having the band cut in lengths just long enough to pass through the holes in the frame; bend them up to clip the outside of the calmes as at 4, 6, 7, 8, 9, J, *n*, *g*, *e*, *d*, Fig. 688, and solder these bits of band on the leads of the light.

Next turn the light over with the bits of band projecting through the holes in the frame, and cut the ends true off to the frame; now with the iron drop a bead of solder on the end, well tin the same, and just when it is in a molten state, quickly put the under part and thick of your thumb on the solder, so as to flatten the head, to form a flat rivet. Of course the flattening must be done quickly or you will burn your thumb; this you, by practice, will soon find which is the best and quickest method. Before you apply your thumb just touch your tongue with it, so as just to damp the flat part of the thumb. The holes on the solder rivet side will be all the better if they are countersunk; the

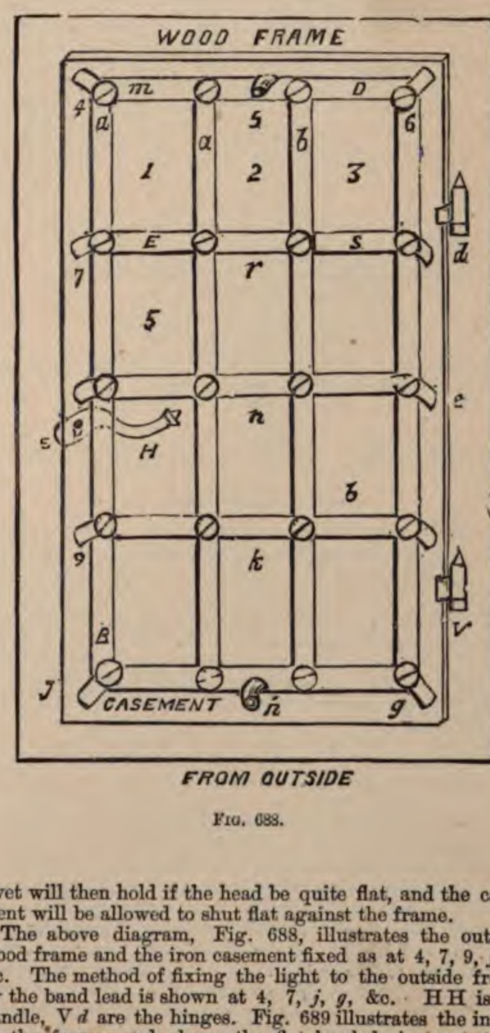


FIG. 688.

rivet will then hold if the head be quite flat, and the casement will be allowed to shut flat against the frame.

The above diagram, Fig. 688, illustrates the outside wood frame and the iron casement fixed as at 4, 7, 9, *j*, *g*, &c. The method of fixing the light to the outside frame by the band lead is shown at 4, 7, *j*, *g*, &c. H H is the handle, V *d* are the hinges. Fig. 689 illustrates the inside of the frame, and shows the flat-headed rivets at 4, 7,

', j, g, 6, &c., it also shows the ties at, r, n, k, &c. S is the fastening, and Y the handle, having a hole in its

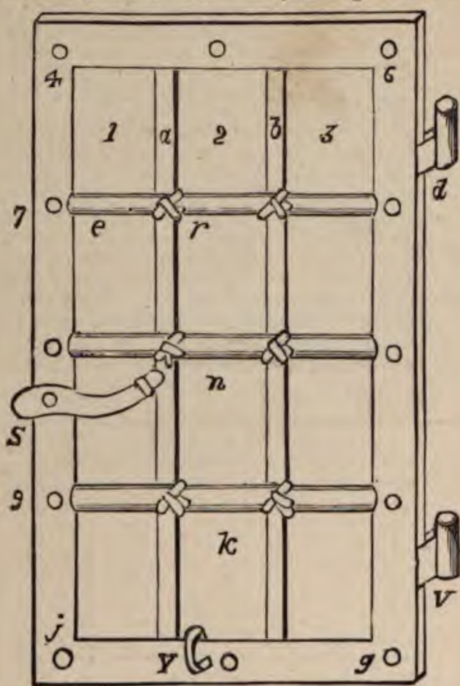


FIG. 689.

base for receiving a hook formed on a holding arm for the purpose of fastening the casement open.

ORNAMENTAL LEAD LIGHT GLAZING.

General Rules.

Now having seen the method of making a simple square lead light, and the fixing thereof, let us make a small pattern light for hanging in a window, &c., as shown at Fig. 690. Here you first line the work out on the glazing board, then fix the lath A B, and the back calme A B, and set the border squares 2. Next the calme 2 Q, cut and fix the pane 3, calme 4, 5 and 6, then the square 7 (here the square may be leaded first), then panes 8 and 9, calme *a* and *d* (or instead of calme *a* and *d*, *e* and *h* may be worked), pane 10, border, calmes, and glass 11, 12, and finally 13, which may then be soldered upon the one side, and turn it and solder up the other, care being taken so as not to nip or otherwise burn your lead, nor must the solder be slobbered about. In this diagram may be learnt sufficient to instruct the apprentice how to go to work generally, as the secret of fretwork glazing is to work your panes in such a manner that each joint will be broken by a lap, as may be plainly seen at the small border pane E; and, secondly, in such a manner that you can finish the work without disturbing any of the fixed panes. For instance, suppose you were to go to work as follows: Set the middle square 7 first. Here the work cannot be steadied during the working; it will be shifting about, and as fast as you get one square fixed, another will get loose. Then again, suppose you fix a border 2, then pane 3, calmes 4, 5, panes 8, 9, borders 11, 12. Here your middle square will have to be pushed down between the two squares 8 and 9, and in this way it can never be made firm, but will always be loose and rickety, and on the rattle; but by following the first instruction, each frame

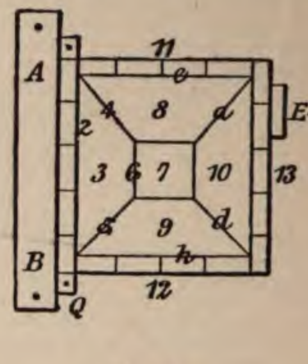


FIG. 690.

and calme is pulled tightly up to each other, which is most important in lead light glazing. Always have an eye to the finishing point, never cut or run your leads through any important part of the figure, such for instance as through a face, hand, foot, or such prominent parts, but on the contrary through the darker points, the shady parts of drapery, and in such places that the leads will show the least; keep your joints and leads in regular order, properly jointed, smoothed, and neatly intersected and soldered into the calmes. Having mastered the simple principle here delineated, which should always be kept in view, of finishing the work systematically, there remains nothing but to practice the work upon different designed windows, which I intend to describe as I proceed.

Perhaps I should now say something about the colours. One thing is certain, and that is that the juxtaposition of the different hues is a very important point in the general effect, for however secular the work may be, it should be done with taste, and therefore some general rule will be necessary as to the fitness of glass and colours used. This is a matter well worthy of your particular attention, inasmuch as in glass the colours participate in the light passing the glass, and by careful attention in the selection of the colours you will soon find out that light will be reflected in strict accordance with the quality of glass and colours used.

There are three fundamental colours, blue, red, and yellow. Blue is the colour which emits the most rays of light, and red the least, whilst yellow occupies an intermediate position as a radiator. For this effect examine Fig. 691. Let RED be the diamond pattern squares in ruby; the circles blue, and the oblongs W, white. Stand away and see what effect this has upon the eye. The blue colours will seem to flash or glaze into the red as far as the larger circles below, and thus produce a purple or violet, whilst the edges of the white will be tinged with the blue. The effect of this work will be cold and violet hued, and if you stand near the red will have a disagreeable effect upon the eye; or dull or sombre if you stand at a distance. Now reduce the size of blue as at A. This at once neutralizes the colour in proportion to the square of reduction. Next reduce the oblong squares of white, or instead of white glass use a yellowish white; then try a greenish white, and the effect will be improved. The radiating faculty of blue is reduced by the heavy leads, or very dark colours. Try the effect of red for the circles, and blue for the diamond squares. Here the blue is too strong for the red, and there-

fore the red will be like a sombre violet and darkish, and should the oblongs W be yellow they will appear greyish, or if green they will with the blue appear yellowish.

A clear blue near a greenish yellow will give a turquoise colour. A blue near a red is an azure, red near straw colour is inclined to give an orange hue. These points are

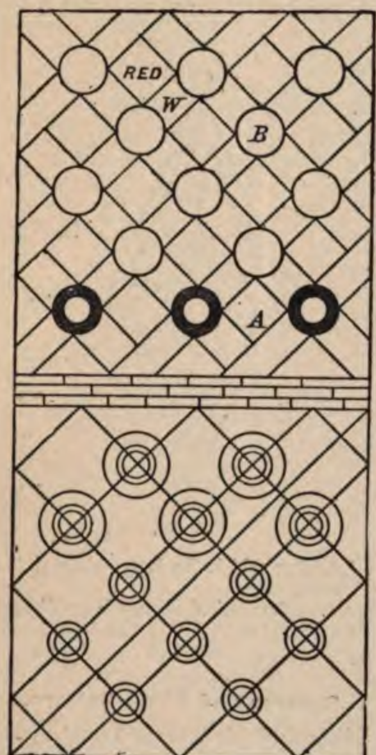


FIG. 691.

best worked out by the workman by placing the real colours side by side, and then judging by the colours themselves so as to arrive at a practical conclusion; always remembering that the great characteristic point to keep in view is, never fix colours which will out-stare or pain your eye. Quietness and harmony blended with a charming outline will, when combined, produce a soft, imposing influence upon the eye and mind of the observer.

Cathedral glass has a kind of rough texture, and this gives a sort of quiet tone to the colours which is not found in the smoother kind of glass; this is due to the light being largely intercepted, reflected and refracted, and thus the light is softened, and its hues mingled.

Varieties of Glass.

There are various kinds of glass used in lead light glazing, and are known by many names. Sheet glass, is the plain ordinary glass. Coloured glass may be either pot-metal or flashed. The pot-metal is that having the colours mixed with the glass throughout, such colours being obtained by mixing metallic oxides, &c. with the glass when in a molten state; whilst the flashed is simply the sheet glass with the one surface coloured. This flashed glass is made to any colour, such as ruby, blue, opal, green, yellow, orange, violet, pink, amber, lemon, &c. Cathedral glass is now made to any tint. Antique glass is also made in all shades, and is as near the colours of the old windows as can be obtained.

"Aven-Turine" glass in slabs, occasionally used in mosaic figure work, is of a sparkling kind, caused by the suspension of the metallic particles or copper filings. It is generally of a brown semi-transparent colour.

"Ambilti" is sheet glass much prized by the Italians, owing to its general brilliant appearance and its softness for staining. I shall not give colours for making up any particular light, as these are usually worked according to fancy as in mosaic work, and scarcely ever are two windows worked alike.

[*Fret work will be explained at description of* Fig. 713; *also see Fret Work.*]

Diagonal Patterns.

This is illustrated at Fig. 692, and is suitable for working round crests, &c. It may often be seen in shop windows as specimens of lead light glazing, and will be easily glazed

FIG. 692.

after the circle is done, which will be readily understood from the following. First lead the crest part, A [for description of this work see Fig. 713, &c.], then put a small border round, then the circular border *b*, then cut the large panes, which may be in one or two pieces, fix them, and finally the outside border, solder, and cement it, and the pattern is complete.

Square within a Lozenge.

Before you can work the pattern you should first learn how to properly construct the drawing, for without this knowledge of the work you will come off very badly with geometrical designs. I have written a work on geometry suitable for striking out all kinds of plumbers' and glaziers' work. This work will be found in the next volume. However, I will show you how to strike this figure here.

Construct the lozenge D A B C, Fig. 693, as follows:—Say that the lozenge is to be made up with two equilateral triangles as shown at A B D C; draw the width A B, and

with this width set the point of the compasses at A, and draw the arc D B C; then from B as a centre strike the

FIG. 693.

arc D A C, and draw lines through the points C B, AD, D D, and A C, and this will give you a true diamond or lozenge.

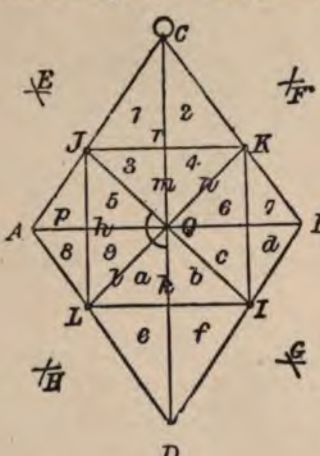


FIG. 694.

Of course the shape may be varied, and may be struck as follows: First determine what the length shall be; say it is from D to C, and the width A B; draw the line A B square to the dotted line and connect the points as at A D C and D B C, which will complete the figure. Now examine Fig. 694. Here is to be seen the square within the lozenge and the diagram which is to be glazed; you have the lozenge, but the square is not yet set out; for this draw the lines *p d*, and *k r*, intersecting at Q. Next bisect any two of the adjacent angles, or as at *f d*, *e p*, C *p*, and C *d*, and draw the lines I K, I L, L J and J K, which will give the desired square.

Now proceed to glaze the figure, Fig. 694. First work the square J K L I with small pieces 3, 4, 5, 6, 9, *a*, *b*, *c*, which may be made in several ways. To proceed, set the rules or straightedges at J L, or L I; then the calme J L and L I, also *l*; now fix pane 9, and *a*; calmes *k* and *h*, then pane *b*, pane 5, and then the long cross calme I J; next fix pane 3, calme *m*, pane 4, calme *n*, pane 6, calme Q, pane C, and then the outside calme I K, K J.

Another method is to first fix the calmes L *p*, C J, and begin by fixing the calme *p* Q, then panes *p*, 8; lead J L; panes 5, 9, lead *l* and J Q; panes 3 and *a*, lead *k*, *m*, *r*,

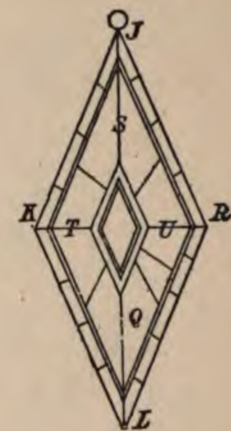


FIG. 695.

then pane 1 *e*, after which the long calme C *k*, and glaze the other side similarly.

Fig. 695 shows the method of encasing a diamond shaped pane within a border as at S T Q and J K R and L.

Squares and Circle Pattern.

The striking out of this figure will require your attention before it can be glazed, therefore a word or two in this direction may be useful. Say that the inner square is struck, now strike the circle about the square; the simplest plan to do this is to just draw two diagonal lines as at

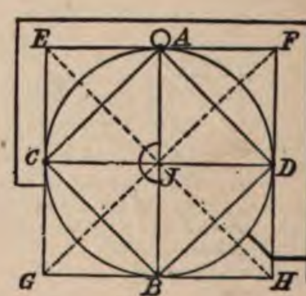


FIG. 696.

A B C D, Fig. 696, and strike the circle from the centre point J. Here you have the circle without any trouble. Next strike the square about the circle; this is done as follows:—Draw the diameter E H and F G square to each

other. Next through the points A C B D draw E F, E G, and H F, at right angles to A B and C D; this will fix a square about the circle.

Having struck out the Fig. 696, let us proceed to glaze it [but for description of the circular part, see Fret Work, Fig. 713].

It is generally made by making the square first, then encompassing it with the lead calme, after which fix the corners and finally the outside lead.

The Triangle and Circle Pattern.

For striking this proceed as follows:—Strike the circle B E F A, Fig. 697; now draw the diameter of the circle

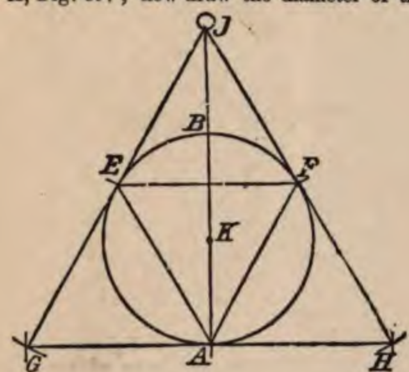


Fig. 697.

B A, then from B with the radius of the circle strike two arcs at E and F, cutting the circumference of the circle, and from these arcs draw the lines E A, and F A; this forms an *inscribed* triangle. Now from E A and F, with the line A F as a radius, describe arcs cutting in J G H; then from these points draw the outer triangle, which completes the diagram.

It is glazed by first making the small triangle E F A; then form the circle E B F A, and add the three corners to form the external points of the triangle; this is usually glazed for window ornaments. In the last two figures no doubt you have experienced a little difficulty in cutting some of the glass, simply because you could not do so with the straightedge. Now this may teach you a lesson, never to design a window which cuts awkwardly, but always work as much of your glass as possible straight.

Diamond and Triangular Pattern.

This is shown at Fig. 698. Windows are often glazed with triangular panes to show off the lead work, as at A E B, H Q E, whilst at other times the panes are cut to a rhombus or diamond pattern, as shown at L M K. When glazed to the former pattern all sorts of colours can be worked with advantage.

The Octagonal and Diagonal Diamond or Lozenge Pattern.

This is illustrated at Fig. 699. Here you may see the octagon as at L H F D B, &c.; the pattern is simply made up with a number of half and full sized lozenges, which

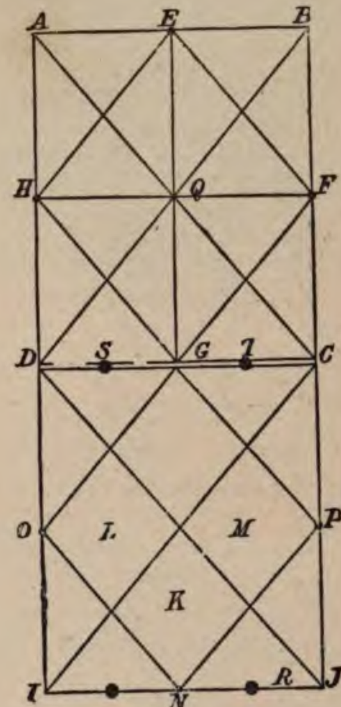


Fig. 698.

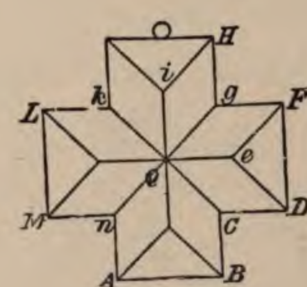


Fig. 699.

being properly arranged will give the window an exceedingly handsome ribbed appearance, especially if the glass is properly selected. You can work the pattern by the methods already laid down, viz., always see how you are to finish before you begin. You can work as many octagons as you require, and finish with half panes or borders; it is rarely made to any size, as it takes considerable time to make.

Hexagonal Panes.

The hexagonal paned window is shown at Fig. 700.

This pattern, like the above, is rarely used, on account of the time it takes to execute the work.

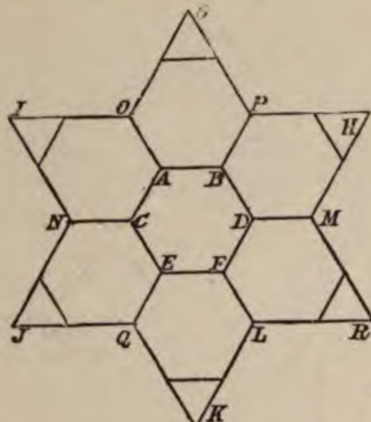


FIG. 700.

Geometrical and Curved Ornamental Corner Pieces.

At Fig. 701 can be seen a corner piece suitable for small penings or corner pieces. This diagram may be worked with the narrow panes as shown at B C, D F, &c., or these

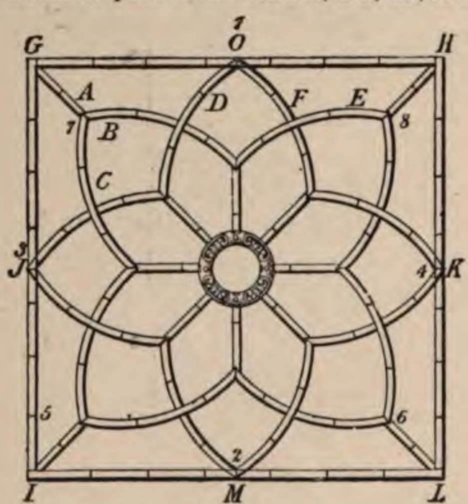


FIG. 701.

lines may be taken to represent the thickness of the lead; if the former they give a very pretty effect if worked in colours, red predominating.

It may be seen that in this diagram every joint is entirely broken, that is to say, you cannot possibly bend the light at any of the leads without breaking a pane of glass; thus the work is stiff and firm, which is one of the points always to have in view when working lead light glazing. If you examine the work at the square lead light, Fig. 684, here you will see that the light can be bent at any of the leads, say at 6, 9, hence one reason for quarry work, which we will now examine.

Quarry Work or Diamond Pattern.

You have seen how we make the square lead light, and how to work a few patterns. I shall now proceed to explain the working of the diamond pattern work. This is done as follows [refer to Fig. 702]. Say that the size is

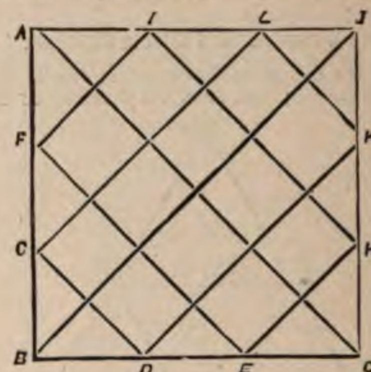


FIG. 702.

4ft. 6in. by 4ft. 6in.; this is a square light with the squares fixed diagonally, and a square pane of glass may be worked in, or a pane cut to a diamond pattern, as those shown at Fig. 703. Suppose you set out the panes of glass as in Fig. 702. Here you divide the bottom into three equal

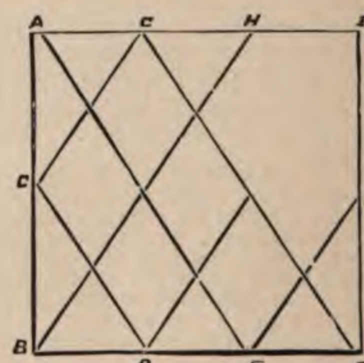


FIG. 703.

parts, as at B D E G, and the side into three equal parts, as at B C F A, and draw your lead lines from the points C D E F A G and again from E H, D K, B J C L, &c. Here it is plain that if the opening be a square one, and every line drawn at equal distance, that square panes must be the result, which has a bad effect. But suppose you had drawn your first line, as from A to E; this alters the angles of your panes; it makes them into a lozenge or diamond pattern (see A E fig. 703). Next draw the line C D parallel to the line A E, but at the same distance as from E to D. Here the bottom is divided into three equal panes, and the side A B into two equal parts. But suppose you require a more pointed diamond-shaped pane for a square opening, and similar to the last; if so, divide the top and bottom

of the opening into four or more panes, as at Fig. 704, and proceed to draw the diagonal lines two or more panes

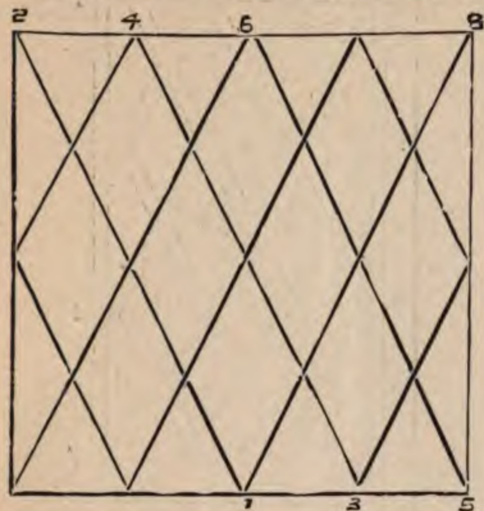


FIG. 704.

from the corner thus: From 1 draw the line to the corner 2, and from 3 to point 4, and so on.

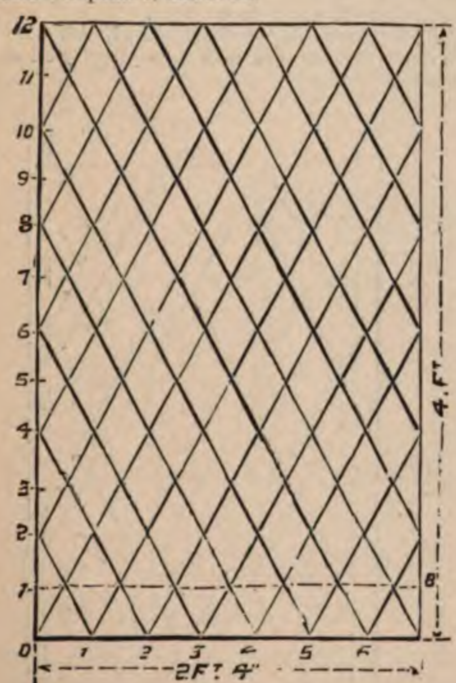


FIG. 705.

Suppose you have an opening, as at Fig. 705, to glaze which is 4ft. by 2ft. 4in. wide. Proceed to mark this out upon your board, and as follows: First, you have the opening, which is 4ft. long, to be dealt with. What sized panes would you like? Say that they are to be 8in. long by 4in. wide, *less the thickness of the lead.* Here you can use seven along the bottom, and six panes to make up the height or length of the window. Proceed to divide it as follows: Divide the bottom as at 1, 2, 3, 4, 5, 6. You

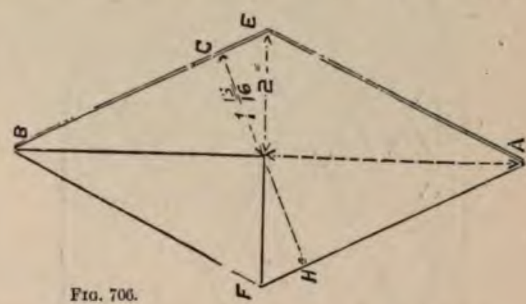


FIG. 706.

know that the opening is 2ft. 4in., and that you want seven panes, therefore, the size (less the lead) must be 4in. across the bottom, but do not cut your glass 4in. wide, for that would be too wide. Remember that you measured across the base or centre of the pane, and not the real width; the real width is from side to side, as from G to H, Fig. 706; therefore, the pane is only about $3\frac{5}{8}$in. A B are the major points, and E F the minor. For cutting these panes out in numbers make a gauge as you did for the square panes. You must take particular care to make the diamond pattern panes work properly in, as from 1 to 12, Fig. 705, also from 1 to 6. Here you should observe that they are all equal at each side, and also at the ends; but suppose you have not set the work correctly out, it may be as shown at the dotted lines from 1 to B; nothing tells a greater tale of incompetency. When such is the case you will have half panes at the bottom where whole panes should be, and in fact the work is bad. At other times your work may be inclined to give half panes up the side where whole ones should be. Notice the bottom corners at 1, B. There are to be seen quarter panes in the corners, and half panes where whole ones should be fixed. I may remark that nothing less than half panes should be seen in diamond pattern work.

Arched Windows.

[*And Setting-out, continued.*]

Now examine Fig. 707 and see how this is struck out, which is done as follows: First, if for an arched frame as at A B C, find the centre as at C, and also at the bottom as at F, and let these be the two first points to be considered, for the top point must come to the centre of the arch, as nothing appears worse than having the centre square half cut through at the centre of the opening; in fact, it is duffing.

Having settled on this point, next divide the height of the opening into any number of equal parts suitable for the glass and also the work; in this our case, say eight. Next divide the top and bottom width of the opening which, in this our case, is into six, three on each side of the centre line F. Next draw the *parallel* diagonal lines *a*, *d*, *f*, *g*, *k*, *l*, *m*, *n*, &c., then the *parallel* diagonal lines O *a*, N *d*, L *g*, &c. (be sure and keep these lines all parallel), and see what kind of a shape your quarry or lozenge is; this happens to be very good because the length of the opening and the dividing, both in length and breadth, is in good proportion, but suppose you had divided the length into $7\frac{1}{2}$ parts and the width into 6, then your bottom middle square would have been only a half square, and th·

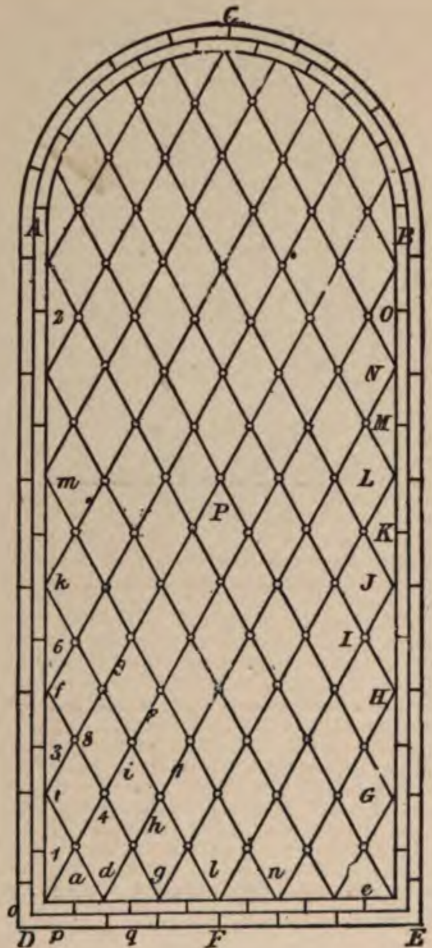


FIG. 707.

outer corners quarter squares, which may be proved simply by placing a piece of paper over the bottom row of squares, or by examining the Fig. 705, at 1 B. This would throw the work out of truth, and it is these little things which you must watch, for I often see such work fixed about London, and which is laughed at by the professional lead light glazier.

Setting Diamond Pattern Panes.

I have explained and illustrated the method of marking out diamond pattern lead light glazing. Now I will proceed to explain the putting the light together. For this examine Fig. 708. Fix the laths A B, B J. Now fix the first calme *w x*, and the calme *x y*, cut and put in the half pane 1, then the lead *a*, next the half pane 2, and next the calme *b*, next the half pane 3, the lead *i*, pane 4, lead *k*, pane 5, lead *l*, and the half pane, 6. Next the calme *e* and the next row of panes. Keep at this until the lot is glazed, not forgetting to knock the panes well and firmly into the lead. Having the lot glazed, proceed to put on the outside calmes and solder them up a" you did the

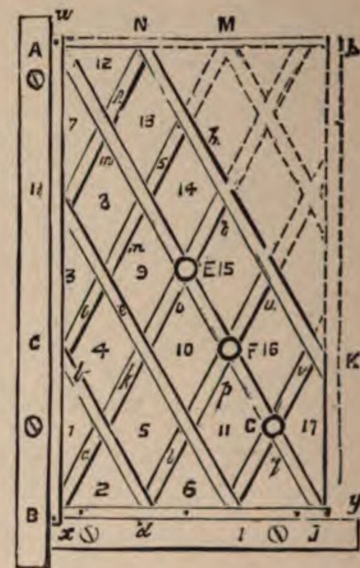


FIG. 708.

square panes. Cement in and clean off. Sometimes this class of glazing is called quarry work.

Fig. 709 illustrates the light glazed with wide lead, which shows that the lead should be properly selected for the size of your panes.

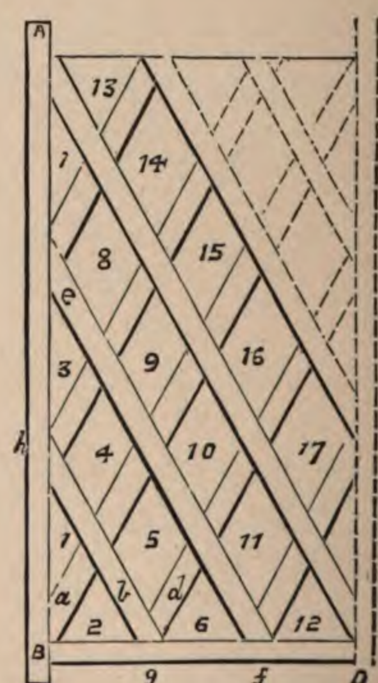


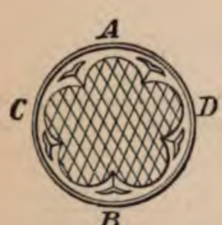
FIG. 709.

The Window Glazed.

This is shown at Fig. 710. On examination of the top part it may be seen that the ornamental stone openings

FIG. 710.

require to be glazed. When this is the case, templets are made to work from, but care should be taken to keep all your lead lines to run straight one with the other, for nothing looks worse than seeing the lead lines some pointing one way and some another. This window also illustrates the iron fixing cross bars inside at A B C D E F G H, &c., for tying the light on.



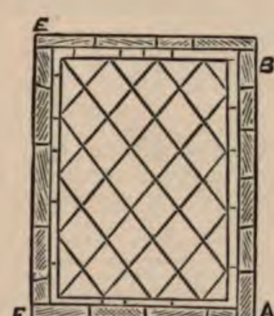


FIG. 711. FIG. 712.

This figure, [Fig. 711] illustrates the light fixed in a round frame, suitable for church window tops, &c.

The Light Finished.

This is shown finished at Fig. 712, and ready for putting into its place, and is fixed as explained at Fig. 684 and description.

Fretwork (Explanation of.)

We have now come to that part of our glazing known as fretwork, which is, as its name implies, of an intricate character, as the leads are often twisted and turned into every conceivable shape. This class of work must be watched, for should you go carelessly to work the chances will be that you will not be able to get a good finish, as explained in the description of Fig. 690; and the glass for such work must never be cut in such a manner that you *cannot* slip another piece inside; viz., suppose you were to cut a piece of circular glass the inside of which is as shown at C A D H B G, Fig. 696, then you could not possibly put another piece with calmes inside without turning back the leaves or sides of the calmes. This is sufficient to show the method of work, and we will next glaze a few borders.

Fretwork Borders, Corner Pieces, &c.

I shall now introduce to your notice a few borders. First examine the Grecian Key border. Fig. 713 is one of

FIG 713.

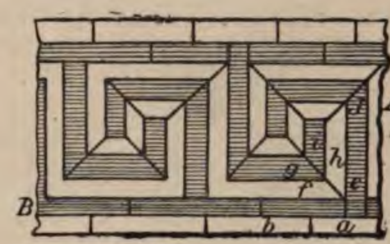


FIG. 714.

the simplest. Fig. 714 is a little more intricate, and Fig. 715 is one with a lot of work.

On examining Fig. 714 the method of working will be understood after what has been written on the foregoing diagrams. I may mention that these last three diagrams require a lot of time and consideration before being commenced.

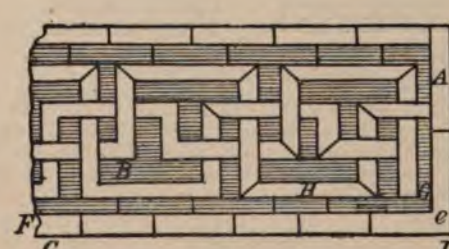


FIG. 715.

Fig. 716 illustrates a border formed from circles, which may be employed for such places as the tops of round

Fig. 716.

Fig. 717.

arched windows as shown at Fig. 707. Fig. 717 is a border having ornamental squares in between the edging.

Panels.

Fig. 718 is a broad panel with a border suitable for conservatory doors, &c. This figure is the square paned of Fig. 730, or at least they go very well together.

Fig. 718.

Fig. 719.

Fig. 719 illustrates a panel with border which is somewhat different to the former diagrams, inasmuch as in this figure the panes are 8-sided, having small squares between this which allows of a small piece of coloured glass being worked in.

Screens.

Fig 720 illustrates a pattern for a screen. Of course any kind of border may be used.

Fig. 720.

Fig. 721 illustrates a circular screen pattern with handsome border. Of course the leads through the border should be worked to the pattern of the leaf.

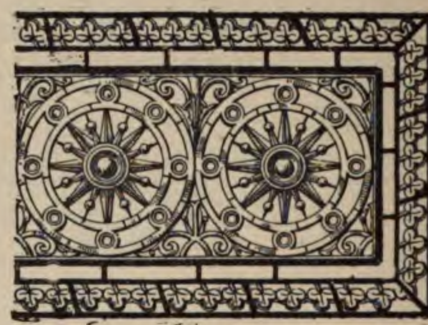


Fig. 721.

Fig. 722 illustrates a blind which I have personally just made for my office window. The dark parts are blue; the white, ruby and white ground.

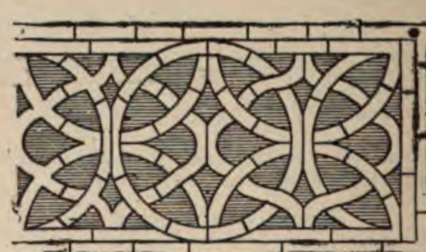


Fig. 722.

Blinds.

These blinds, Fig. 723 and Fig. 724 may be made to any shape, and are made to dispense with the old wire blinds;

they are very effective. Crests and monograms are often worked in with these blinds. Fig. 723 illustrates a shield worked in with the squares.

Fig. 723.

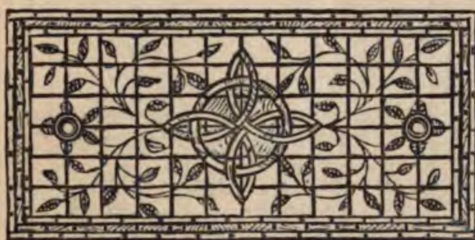


Fig. 724.

Half Circular Windows.

This is illustrated at Fig. 725. First glaze the bottom row A, then glaze and fix the circle, then the second row

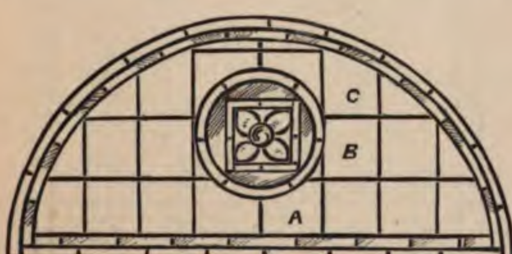


Fig. 725.

of panes B, next row C, and put the border on. Next glaze Fig. 726. Begin by fixing the long row of panes B, or you may begin at the bottom row, viz., if the calmes are not long enough to reach from top to bottom. The border should now be put on.

Trapezoidal Shaped Panes.

This is illustrated at Fig. 727. There are several methods of glazing this light; one by setting the calmes from corner to corner of the light, and working from the centre, and down the diagonal lines; in this case you may use longer leads than you can if working from the corner, as shown at 1, 3, 2, &c.; this kind of glazing has a very pleasing effect upon the eye if properly arranged.

Fig. 726.

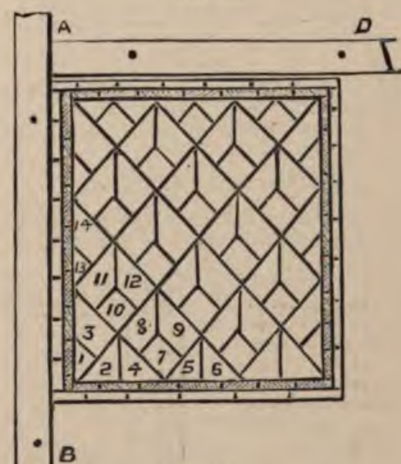


Fig. 727.

Corner Pieces.

Fig. 728 is a corner piece, which should be made for practice, or to show off the cutting—in cutting the glass to any

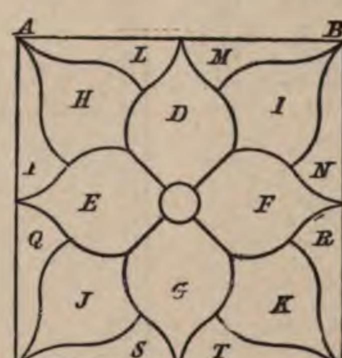


Fig. 728.

shape. N.B.—Never cut glass to form an acute angle, as shown at B, Fig. 715, where may be seen the diagram left purposely unfinished at the meeting point of the glass. If the glass is cut in this manner it, in time, will be sure to break across the angle.

Fig. 729 illustrates a very pretty circular corner piece. It is made by first leading the bull's eye or centre, then the

FIG. 729.

leaves and balls, then the two middle ring leads must be, worked together, which will take a considerable time to execute, but is a masterpiece of work if *properly* handled.

Ornamental Fretwork.

This is illustrated in the following windows, and will, after what has been written, be easily understood from this brief description.

First, all designs must be drawn by the artist or glazier full size on a board or paper, to show every lead and joint, and great care must be taken to work your glass according to the rules laid down in the description of Fig. 690.

FIG. 730

Let us examine Fig. 730. This is a small pattern easily worked. You may first fix your lath as you did at K L Fig. 673, then fix your outside calmes, then pane 1, 2, 3, 4, 5, 6, 7, etc., with their respective leads, and work away until the lot is set, taking care that the ends of your leads are properly jointed smoothed, and neatly intersected

FIG. 731.

into the calmes; the solder should appear clear, round and plump, or like little buttons, for nothing appears worse than slovenly soldering.

The following diagram [Fig. 731] will afford good practice for fretwork, as it may be glazed in very small pieces, and in ordinary cheap glass.

You may commence this figure by starting from the bottom left hand corner, working the vase, and upwards.

Figure Work.

This is illustrated at Fig. 732. The lines here are of the plainest possible character, and will be as easy to work to

FIG. 732.

as an ordinary square panel light. Here from A to B the leads are nearly in a straight line, which, of course, is bad in figure or fretwork, but is shown here purposely.

Now examine Fig. 733. Here the lines are somewhat improved; they are more broken and the effect is better.

FIG. 733.

Now examine Fig. 734. Here the outline of the leads is still more varied; still they are far from being perfect; they are too heavy and too much resemble that shown at Fig. 709; besides in this Fig. 734 you have a continuous line from the right foot to the top of the head; this line should be broken at the waist. Then in this figure you have an objectionable line under the right arm. The whole of this

FIG. 734.

angular line should be away, as it is not required; in fact, the woodman appears to be bound up, instead of being free and loose.

Fig. 735.

Fig. 736.

Now examine Fig. 735. Here the figure is properly lined out and leaded: and instead of being bound in fetters, as shown in the last figure, the Fig. 735 is light, and at no point objectionable. This figure may be worked from the left hand bottom corner, as at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, etc., or otherwise, and is a very easy piece of fretwork to execute.

Fig. 737.

Geometrical and Ornamental Glazing.

This is very well illustrated at Fig. 736. Here we have a nice centre, which should be the first thing to glaze; then fix it and glaze all round until the lot is worked, finishing with the borders.

Fig. 737 illustrates a very pretty window, suitable for altars, etc., and which, if you have been attentive to the instructions given throughout this work, you will be able to glaze without further instructions.

Next examine Fig. 738. Here is a whole lot of intricate lines, and as they should be, for your perusal at this stage. I want you to examine them and to put improvements where you may think it necessary; though the work may and has been glazed exactly as here delineated.

Fig. 738

STABLE, COWHOUSE AND PIGGERIES DRAINAGE AND VENTILATION.

THE drainage of stables, cowhouses, piggeries, and other outbuildings, such as slaughterhouses, kennels, &c., is of far more importance than is generally supposed. Many think that anything is good enough for a stable, but I contend that the stable drains require as much attention as those belonging to the house. I have on the plan, Fig. 394, shown a system of drainage, and have very briefly referred to it on page 171. I have also referred to stable drainage in the Architect's Specifications, page 305, and have there spoken of the drainage from stables being caught in cesspools for manure; this being so, we have now only to deal with the planning of the gutters, the kind of fittings, ventilation, and the necessary water supply. Assuming that the drainage is to be collected into cesspools, then work as I have referred to on pages 136 and 323, under the heading "Underground Tanks"; of course this would be a cesspool. The drains are made to run into this cesspool just as though it drained into a sewer. The ventilation fresh air inlet is taken into the crown of the cesspool, and the air made to pass through the whole line of drainage; or the cesspool may be ventilated separately, and the drain trapped, and a fresh air inlet provided in the usual manner, but I prefer the first plan, viz., without the trap. The method of calculating the size of cesspools must, in a measure, depend upon circumstances; but for general work you may safely work as follows: For one horse the diameter should be 4ft., depth 10ft., and double the contents for each additional horse; this will last from a month to six weeks without emptying. If allowed to pass right away into the sewer, then work as per plan, Fig. 394. Now turn to the illustration, Fig. 739, which shows the stable as fitted by the St. Pancras Iron Company (in fact they can supply any of the fittings shown in this my work on Stables, Cowhouses, Piggeries, &c.), also the drains with a channel A, and it also illustrates the trap, Figs. 740 and 741, as supplied by the St. Pancras Iron Foundry Company. The trapping of stable drains requires your particular attention, inasmuch as it is not every trap which will answer for stable purposes; the trap must be of *strong* make, easy to flush out, easy to get at, and one which will not allow the horse

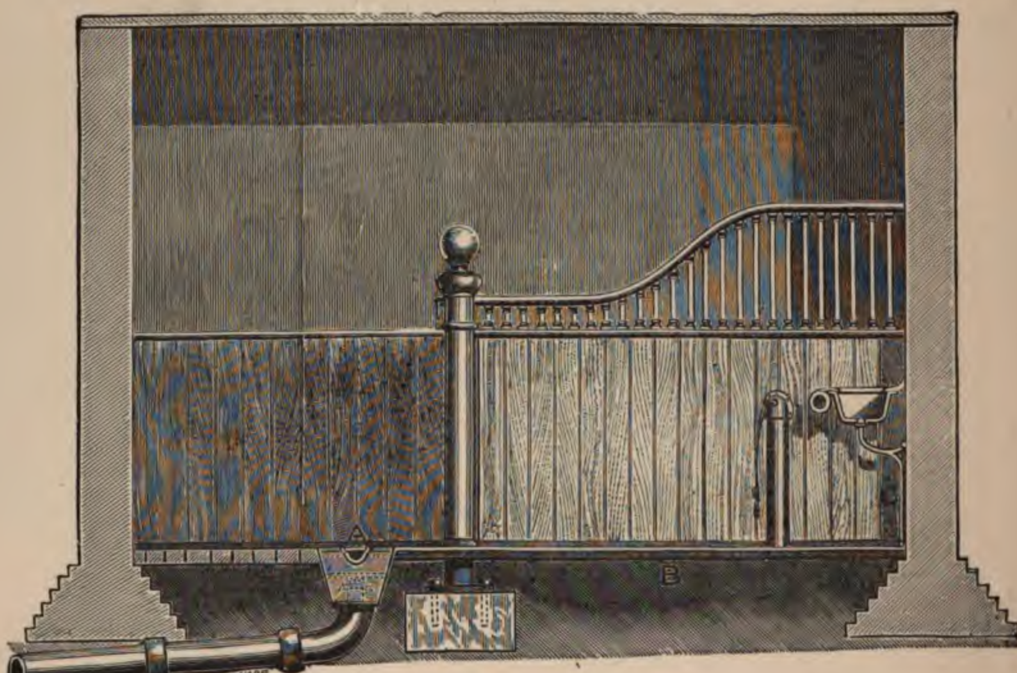


FIG. 739.

dung nor straw to pass into the drains (bell traps are very bad for this purpose, see dotted lines in trap, Fig. 739), and lastly, which is of great importance, one which the cover cannot easily be knocked off by the horses' hoofs, and one which will prevent the breaking of horses' legs should the top be accidentally left off. The stable trap, Fig. 740, is an elevation of the stable trap which I prefer to use. Fig. 741 is a section of the same. It may be seen that this is mares it should be at A, Fig. 739, or at the foot of the stall; but for a horse it should be about the centre of the stall as shown at B, in Fig. 742, or as in the plan of loose box, Fig. 743, with the pavement falling towards the centre. Sometimes it will be best to fix the traps near the stall posts, for here they are out of the way of the horses' hoofs. Fig. 747 will answer for horses or mares, as in this figure the conduit gutters run up the centre of the stall.

FIG. 740.

FIG. 741.

FIG. 742.

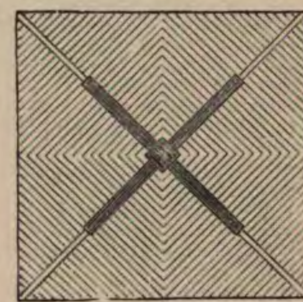


FIG. 743.

a lipped trap with the trapping water in the bottom, and just above the top of the lip there is a loose strainer fixed just below the top grid. The use of this loose strainer is to prevent the straw, etc., getting into the bottom of the You cannot be too particular about the planning of stable drains, as horses are very sensitive to bad drainage. I will, therefore, give you a plan or two of stable drains which I trust will be sufficient for explanation.

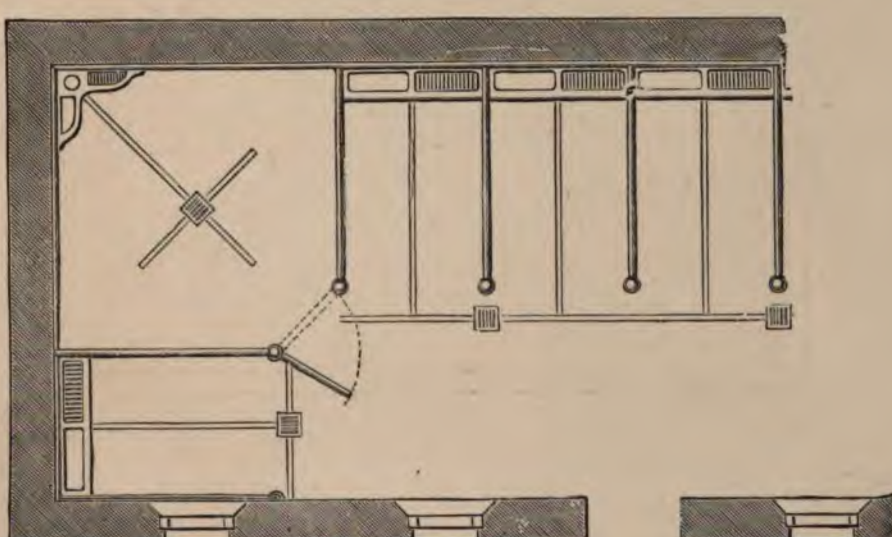


FIG. 744.

trap, and also to prevent the animals from getting their legs into the bottom of the trap. This trap is easy to clean out, and answers its purpose exceedingly well.

The next thing to be considered is the position for fixing the traps. This depends upon the gender of animals: for

Let us assume that we have to drain a four stall stable and one loose box, such as is shown at the plan, Fig. 744.

Here we have three stalls on one side, one at the end, and a loose box in the corner; the drainage from these stalls is conveyed by the gutters into the traps, two of

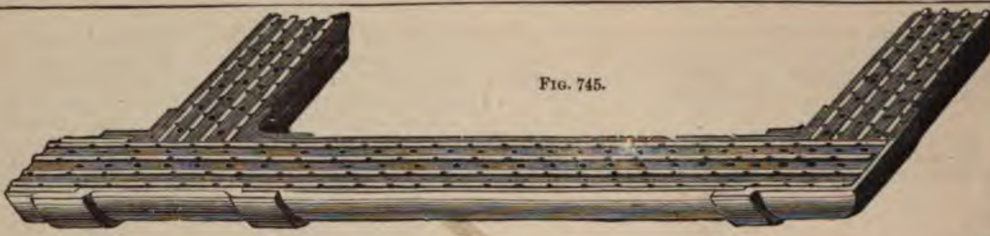


Fig. 745.

which are fixed at the end of the stall posts, and one in the centre at foot of the end stall, and one in the centre of the loose box. Such drainage answers for horses or mares.

There are various kinds of guttering suitable for stable work which are known as conduit gutters, &c., such as are shown at the enlarged views, Figs. 745, 746, &c., and which may be seen well illustrated and fixed in Fig. 747, and which is a barrack stable of the modern type, suitable for horses or mares.

The next thing which we have to consider is the pavement, which requires very particular attention, for if the pavement be bad the stable must of necessity be a stinking one.

The pavement should be constructed thoroughly non-absorbent, water tight, easy to drain dry, and easy to sweep clean, be made of durable material, and not slippery.

One of the best kind of bricks for stable paving purposes,

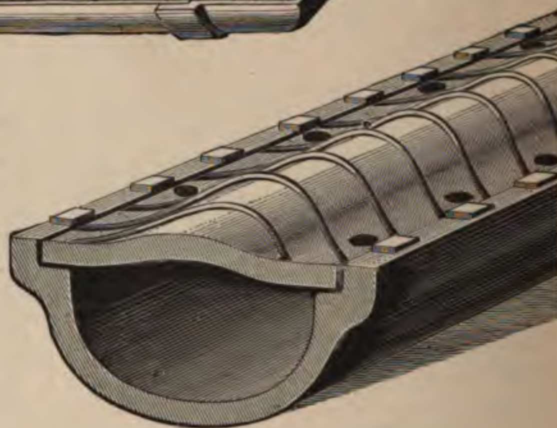


Fig. 746.

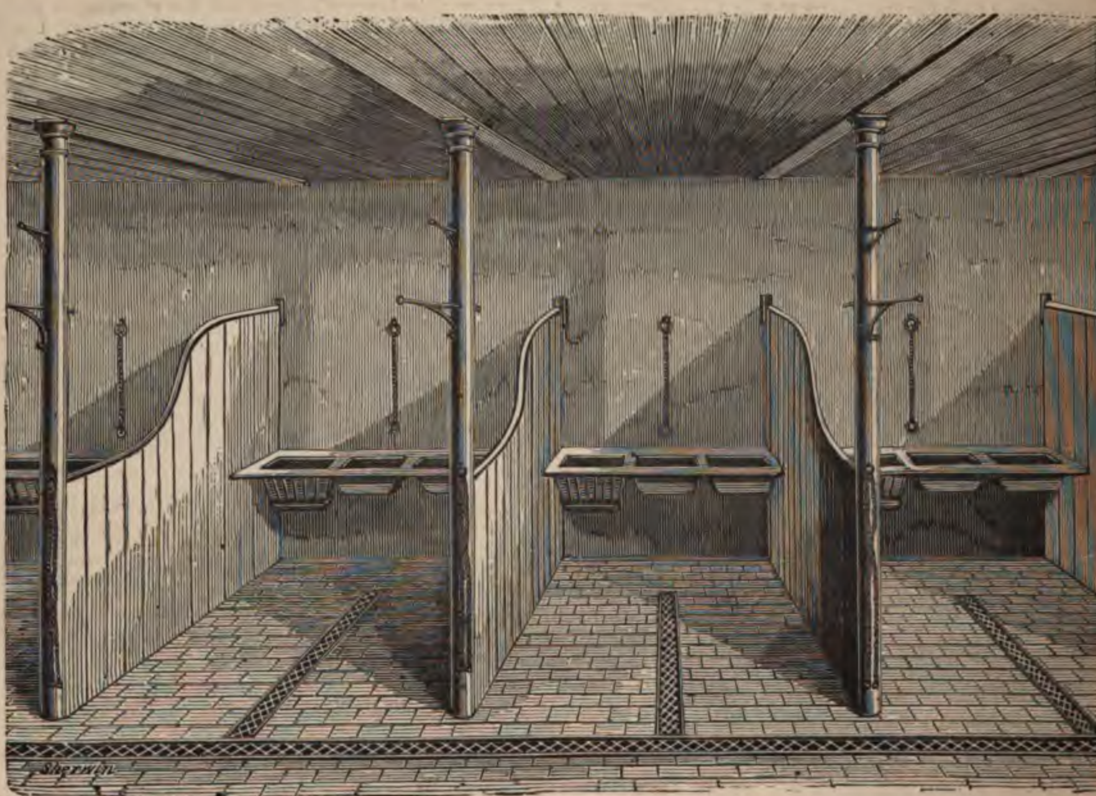


Fig. 747.

is the chamfered edge brick, shown at Fig. 748, which was patented some years ago by the St. Pancras Iron Foundry Company. This brick should be laid on a good solid

FIG. 748.

foundation of concrete, and set in Portland cement, and afterwards *thoroughly* grouted in, so that not a crevice can

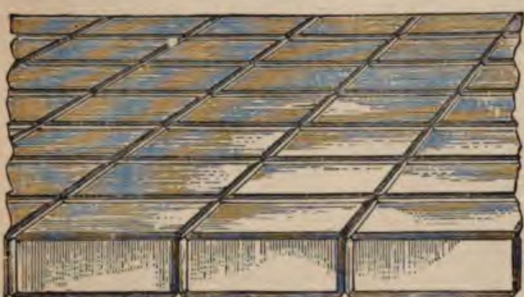


FIG. 749.

remain under or between the bricks for the urine to penetrate. The bricks are shown laid at Fig. 749.

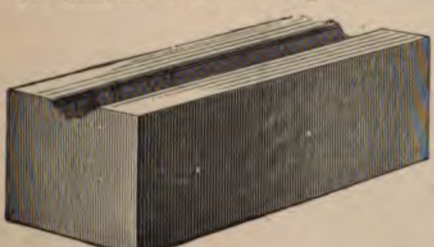


FIG. 750.

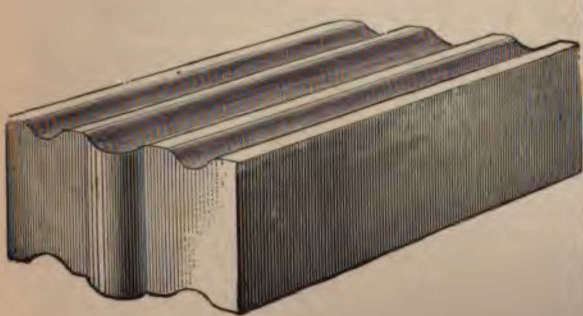


FIG. 751.

The above-named Company have since the date of the the chamfered edge bricks brought out another kind of brick which is, so far as regards the draining, and easy sweeping, an improvement on the former, inasmuch as in this brick, Fig. 750, there is a straight smooth channel on its upper surface, which admits of the besom being easily drawn along these straight grooves, leaving nothing behind as would be the case in Fig. 749, more especially if the stableman be lazy. Not satisfied with this brick, there has been another one invented, which consists in forming the brick with more than one groove, as illustrated at Fig. 751. This brick is also further improved, which consists in forming on its ends a tongue and groove, which ensures proper laying, and also ensures stability.

These bricks are shown laid out at Fig. 752 and Fig.

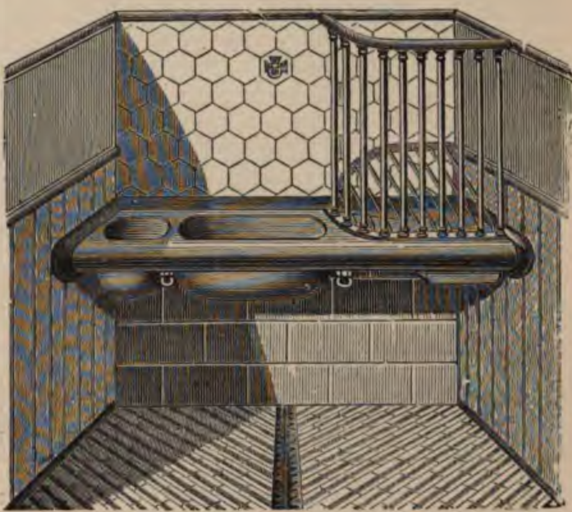


FIG. 752.

753. These stalls are shown with the guttering running up to the manger, and with the bricks laid at an angle, Fig. 752 being rather flatly laid, whilst Fig. 753, especially the two middle stalls, illustrates the flooring in ridges; this

FIG. 753.

is one of the important points which should be studied in the flooring of a stable, for if the bricks are laid too flat, it is impossible to drain dry, whilst if it is too steep, the horse cannot stand or lie in comfort.

Fig. 754 illustrates the pavement of a stable very well laid, with the guttering running from the outside direct up the bottom of the stalls, with proper stall channels passing

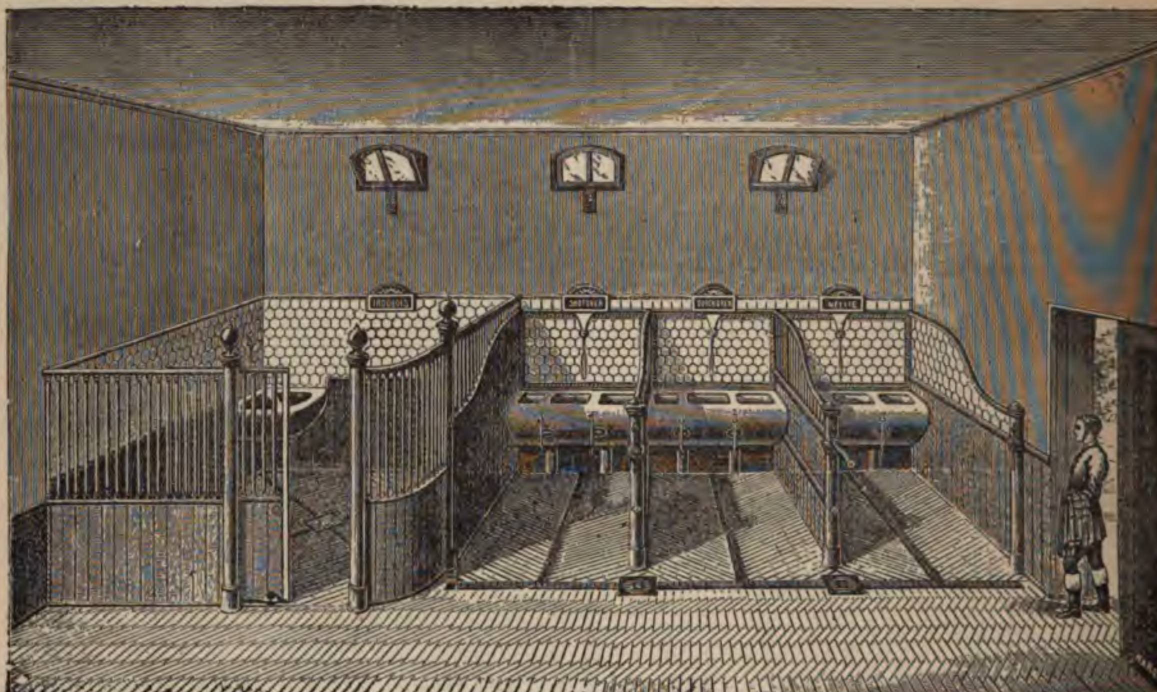


Fig. 754.

up the centre; in fact, this is a perfect piece of stable drainage and pavement.

Stall Water Supply.

The next question is the water supply to the stalls, etc. Every well-arranged stable has its water trough with water laid on, with waste pipe and plug, for cleaning out, as shown on the left hand side of the stalls, Figs. 739, 742, 744, 747, 752.

This water supply need not be of any elaborate design, a simple pipe and three-way cock, with enamelled iron water trough, such as is shown at Fig. 755, being all that

Fig. 755.

is necessary; the waste pipe can be arranged as shown to run into the head of the gutter, as shown at Fig. 756, which will tend to keep the gutter cleared. In fact, it is a good plan to lay on a water supply to flush out these gutters. Such I did to some stabling some twenty years ago, and which gives great satisfaction.

Fig. 756.

Of course, the water may be laid on to the water trough with a ball cock and feed cistern, but when this is the case, the trough must have a lid to prevent the animal drinking

when it comes in hot, etc. When the trough is supplied without attention, viz.: with feed cistern, it often gets neglected by not being regularly cleaned out, which is of great importance.

Water Supply to Stables Generally.

This requires some little attention. In large stables there should be a constant water supply laid on, but the cocks should be fixed out of the way of the horses, and is best fixed in a niche lined with 7lb. lead, as shown at Fig. 757, with the sink grating dished down. The lead is brought round the front, and worked over the beads, where it is fixed with lead-headed nails. Sometimes this sink is supplied with only cold water, at other times it has hot (see Figs. 760, 761 762, &c.,) and cold water supply, whilst at other times an extra cock is provided for a hose, with brush, Fig. 758, for washing the horses' legs, etc., which also tends to keep the gutters flushed out.

FIG. 757.

The cistern must be placed over a lead safe, or otherwise fixed, so that it will be quite impossible to overflow upon the horses—*very important*.

The coach house water supply should be somewhat similar to that shown at Fig. 757, excepting the hot water cock, but the coach house cock should have a screw for a union, or better, fitted upon an extra cock; then the coachman can draw a pail of water with the one cock, for douching purposes, whilst the other is engaged with the

FIG. 758.

rubber tubing and self-supplying carriage brush, as shown at Fig. 758. This brush has a hollow back, and is perforated, to allow the water to jet out as shown; A is a rubber tube which is connected on to the water supply.

Carriage Washing Table.

The carriage table is simply a square paved floor, with hard, smooth floor, such as bricks set with cement, etc., there should be a fall each way towards the gully trap, which should be fixed in the centre of the table, as shown at 7, Fig. 394. The grating should be at least ten or eleven inches square, and of strong make; Fig. 759 represents one suitable for this purpose, being hinged at A for cleaning out the trap.

FIG. 759.

Hot Water Supply to Stabling.

Of course there are many methods of supplying hot water for stabling. Sometimes from the boiler of the house,

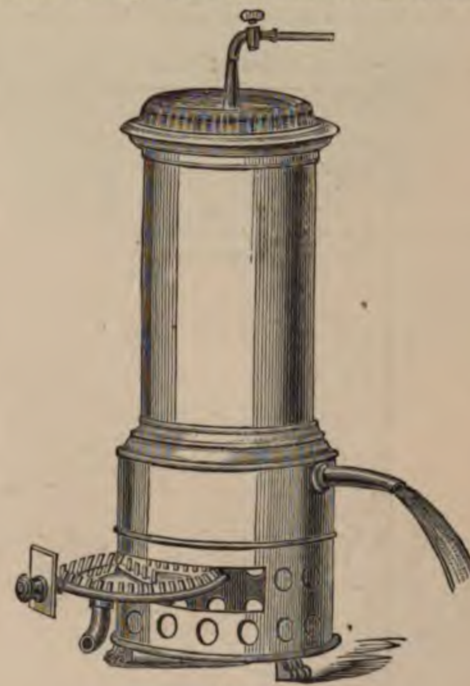


FIG. 760.

other times from the harness room boiler, and at other times from an independent instantaneous heating boiler, heated

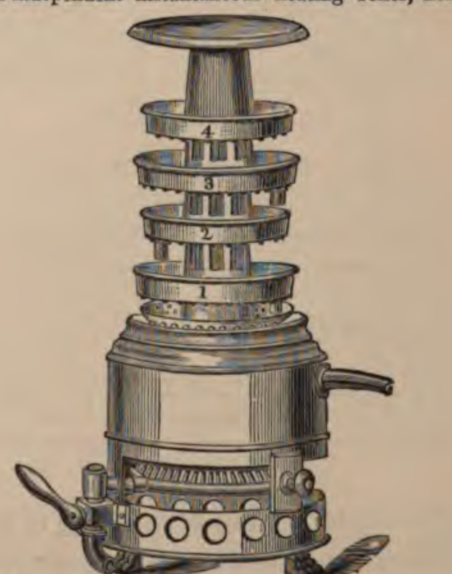


FIG. 761.

with oil or gas, similar to that shown in Ewart & Son's patent Califont. Fig. 760 is an elevation; Fig. 761 is an

elevation showing part of the outer casing off; and Fig. 762 is a sectional elevation.

For stable purposes these boilers are exceedingly useful, as the coachman is often requiring small quantities of hot water at a minute's notice for making bran mashes and such like.

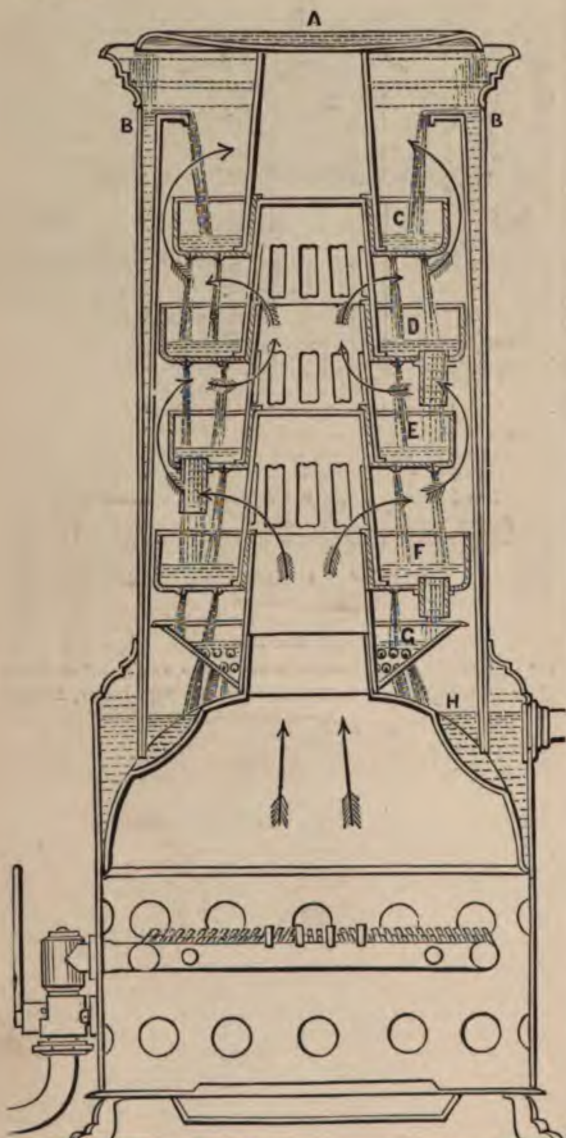


FIG. 762.

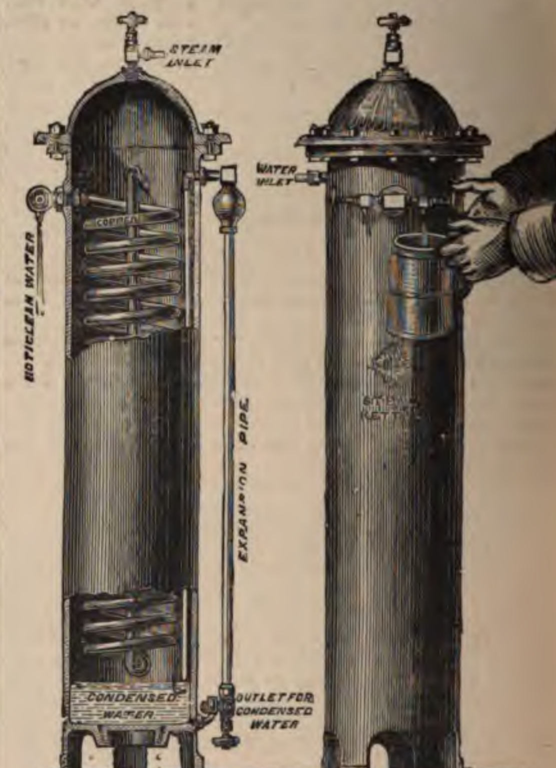
The following will explain the working of the above boiler.

The cold water first falls (from any convenient tap) into the basin A, and overflows into the outer jacket or chamber B B. As soon as this chamber is full, and the water runs over the inner ring, it flows into the top tray C which is marked 4 in the Interior Elevation, Fig. 761 (also see trays (3,) (2,) (1,) same Figure). From this tray the water percolates through holes in the bottom to the next tray D^3, and thence to E^2 and F^1, out of which it flows into the inverted cone G, and thence on to the top of the dome H. Here it collects until it overflows through the spout I.

It will readily be seen that in falling from A to H the water is repeatedly brought into contact with the heat from the gas ascending, as shown by the arrow marks, while at the same time the heat is repeatedly driven, by the obstruction of the tray, against the inner ring of the jacket. By means of this double action the heat is almost entirely absorbed into the water, and the escape which takes place round the basin A is cooler than the water which is poured out at the spout I, near H. When steam can always be readily obtained, you can with advantage use the steam kettle.

Steam Kettles.

The following diagram illustrates Bailey's instantaneous steam kettle.



The inlet at the top allows steam to enter; this, surrounding the coil pipe, boils the water which it contains; the water passes through the hot pipe at its full pressure, and is made to any temperature, which can be regulated by the valves.

Clean hot water can thus be readily obtained, as the water touches nothing but the clean copper pipe. The steam condenses in the cistern, and, to allow it to escape, the pressure of the steam forcing on the top of it causes the water to ascend, and as it passes moderately cold down the outside expansion pipe the pipe contracts, and thus automatically opens a valve, which allows the water to escape.

Cow House Drainage.

Cow houses should be drained with a main drain running down at the foot of the stalls, but the trap must be kept some distance away from the heels of the cattle, and opposite the stall partition, as shown at Fig. 763, for cattle dung is generally of a sloppy nature, and would run into the trap, which would soon become blocked. Sometimes the channel runs right away without any intercepting gratings to a gully trap outside the building; in fact, the Act for cow sheds, of July 9, 1879, states that it "shall, where practicable, be outside the shed."

Copy of the Act of Parliament of July 9, 1879, and Regulations as to Dairies, Cow Sheds and Milk Shops.

"7. Every cow shed shall be well paved with Stourbridge or other impervious brick, or other impervious material, set with cement properly bedded on concrete, with a proper slope towards a gully hole, which shall, where practicable, be outside the shed; such gully hole to communicate by an adequate drain of glazed stoneware pipes with the public sewer, and be trapped by an appropriate trap, and be covered with a locked grating, the bars of which shall be not more than $\frac{3}{8}$-inch apart; excepting that, not exceeding three feet of the foremost part of the stalls may be paved with chalk or other similar material." [See Acts of Parliament, page 292.]

When the gully trap is carried outside the shed, this prevents the cowdung getting into the drains.

The space given for each cow is 8ft. × 4ft., or, for two cows, 8ft. × 7ft. will do.

AIR SPACE.—There must be an air space of at least 600 cubic feet for each animal kept; but this is for places that are *thoroughly ventilated.* In other places 800 cubic feet is required, and the ventilation good. Should the shed be very high the Act will not let you take advantage of it, for then the upward measurement shall only be taken into consideration of 16ft. in height, of estimating the air space. You are required to fix drinking troughs for each cow, and which must be properly and constantly supplied with water from a large cistern fixed *at least 6ft. above* the floor of the cow shed; this large tank must be "of a capacity equal to twelve gallons of water for every cow lawfully kept; and shall have no communication with any water closet or drain by means of waste pipe."

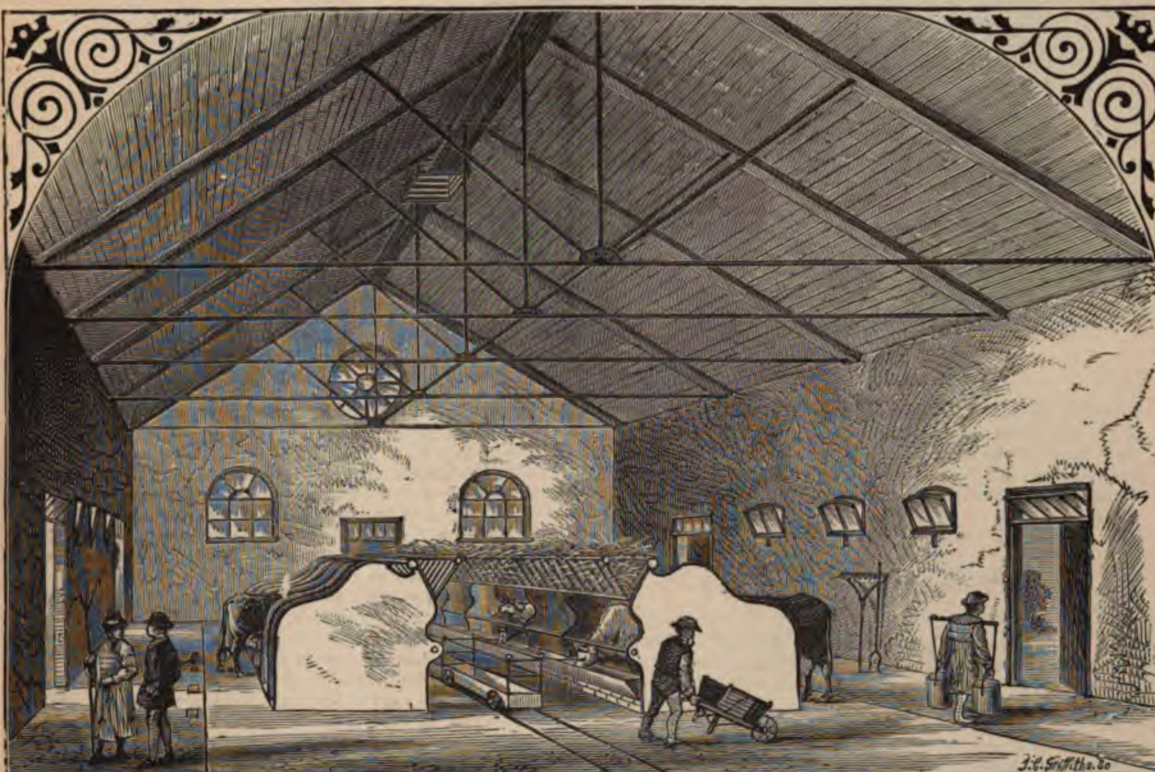


FIG. 763.

Piggeries.

These places require particular attention in the matter of draining; they should be drained towards the centre of the sty, with a gully trap with grating, and in such a manner that the slops will readily drain away into a cesspool. Here a good supply of water and rubber hose is indispensable for swilling down the sty, whilst the floor of the cot part should be kept two inches higher, and be built

in such a manner that it will easily be kept dry. There should be a water trough properly supplied with water from a feed cistern, and the trough supplied with swing lids, as shown at the left hand side of Fig. 764, for preventing the animals feeding when the troughs are being supplied with food. There is one important thing about a pig's cot, it should be dry and warm, as, however much they may like to wallow in the mud, there is no question but what they like a clean, warm, and dry bed, and in winter time the swine will thrive better if such be given.

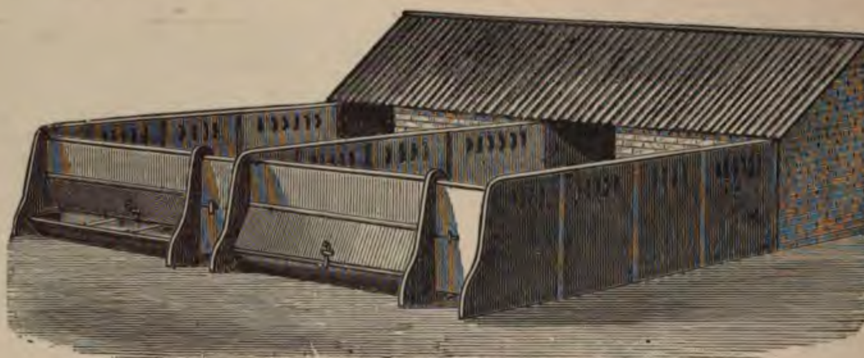


FIG. 764.

Slaughter House Drainage.

In every slaughterhouse the blood is caught in sunken pots, such for instance, as into a large iron boiler, or into a cesspool, where it can be easily ladled out. The method of paving is with asphalte or flag-stone set in cement, with good fall towards the drain. The gully trap and the drainage is similar to that of the carriage washing table with the usual bullock-holding ring and post fixed at a convenient spot. There should also be a good supply of water near, in order that the floor may be readily swilled down. Where the guts are to be cleaned, viz.: such as calves' or pigs', there should also be a large sink in a light part of the building, also rinsing trays with large fixed domed strainers, having ⅜in. holes; a round way stop cock, fixed upon the waste pipes, is by far better than the ordinary washers and plugs, because the washer and plugs necessitate the strainers being too small, and which should not be of less diameter than 6in. The waste pipes from these sinks and trays should run into the gully trap.

Stable and Cow-house Ventilation.

Ventilation is a subject which of late the plumber has had to deal with. There is only one simple principle to at all times keep in view, viz., the oxidation of the vitiated air, which is best done by the free circulation of the air from external to the internal atmosphere. Remember that warm air, like hot water, always ascends with or without pipes, and if this is the case the whole secret of ventilation lies in a nutshell. Provide sufficient size pipes to bring fresh air to the place, and sufficiently large to carry the vitiated air away, but much will depend upon the heat within your room, for unless this heat be of a higher degree than that of the external air, the ventilation cannot be considered self-acting; then artificial means must be employed, such, for argument's sake, as a fan, water jet, fire, gas light, cowls, &c., fixed in the exhaust pipes, &c., &c. As a rule, stables and such like places are warmer within than the air without, and so nature provides the propelling power. For instance, in a room full of people, where there is no free ventilation the air soon becomes heated, and if not let off, it in time becomes offensive, hence the necessity for free ventilation. Let us suppose that the cow shed Fig. 763, or the stable Fig. 765, is the place to be ventilated. Now according to the size of the stable, so must be the size of the vent pipe which is here fixed with a bonnet or cone B, and in the centre of the ceiling, also see the arrows near ceiling in Fig.344. Say that the size of the stable to be ventilated is 15ft. square, here, a 6in. square pipe will be large enough, but remember what I said about the room being kept hot or cold, or of a greater heat than the external air. The sizes of the pipes are of great consideration; for instance, a room four times the above size will require a ventilating pipe four times the size of the 6in., viz., a 12in. square pipe, my method of reckoning being as follows: In a 15ft. square building we get 15 times 15 or 225 square ft. super., and in a 6in. square pipe, we get 36 superficial square inches. Now if you double the length and width of the building, viz., to 30ft. square, you get four times the superficial contents of the 15ft. room, and if you double the width and thickness of the 6in. square pipe you will have it multiplied 12 by 12 and so get four times the size of your 6in. pipe, and it is upon this principle which I have always worked without a solitary failure. Some people reckon on cubical contents of the building, viz., length, breadth and height.

It should be distinctly remembered, that you cannot ventilate a building simply by sticking a pipe in the wall, or ceiling, without bringing fresh air from the external parts, which requires more attention than you at first may imagine. First the fresh air must be pure and good, and be brought into the building in such a manner that it will not cause unpleasant draughts. The place of entrance must be carefully selected, and the air properly distributed, and if possible in such a manner that it will flow all over the building; and, as shown by the arrows on the right hand side of Fig. 344, which illustrates the fresh air inlets coming up through the tubes from the external air. For stable purposes the fresh air is often brought in through pipes as shown at G, Fig. 765, when it passes up through the stall post as shown at J; at other times it is brought through an opening at the head of the stall, as shown at H; also at Figs. 753, 754, also on the right hand side, in

the cow shed Fig. 763, and also in many other ways. N.B. The theory is to have the fresh air to enter at the bottom of the stable, &c., but in practice it is best fixed as shown

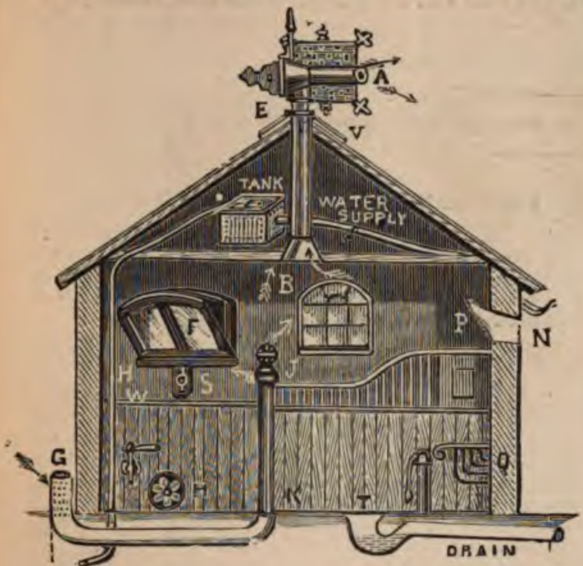


Fig 765

in Fig. 765, &c. There is one thing which you must guard against when dealing with these fresh air inlets. Never fix them to bring in the cold air to give draughts, or to blow upon any part of the cattle. My practical experience teaches me that for stable and cowhouse work, the

Door Vent.

Fig 766

fresh air inlets are best placed as shown in the engravings, having Sheridan's principle ventilators as shown at Fig. 766, and which is so arranged for easy opening to admit fresh air, and for preventing its direct descent. These ventilators can be adjusted with a regulator as shown at C, Fig. 767, and are usually fixed as shown in the wall at Fig. 766. They may also be had glazed as shown at Fig. 767. At DOOR VENT, Fig. 766, may be seen a circular sliding ventilator for fixing on doors and shutters.

Fig 767.

When selecting these ventilators, see that you get them large enough (but not too large) for the purpose of supplying the necessary quantity of fresh air to the building. It is important that the holes in the external grating, E, F, Fig. 766, be of sufficient size to supply the necessary quantity of fresh air. There will be times when you cannot possibly take the vitiated air through the ceiling or roof part of the house, as you did in Figs. 763 and 765; in such cases you

Fig. 768.

will probably be able to fix an Arnett's exhaust hinged outlet ventilator for allowing the escape of the heated and foul air as shown at Fig. 768. Sometimes these escape ventilators are fixed into the chimney flue, and with ver good results

Warming Air before it enters Building.

In conclusion, I may say, that sometimes the fresh air is heated in pipes, &c., before it enters the building intended to ventilate, and so a room may be kept warm without having fires or hot water pipes in the room itself. I have done some of our City of London churches on this plan, and with very good results.

ARCHITECTS' SPECIFICATIONS FOR SANITARY PLUMBING WORK.

The Author may be consulted on any point connected with these Specifications

N.B.—I shall give several different specifications to suit the different classes of work which you may have to deal with. For instance, in some places you will have to contend against the different regulations of the water companies, such as the fixing of suitable water fittings, viz., waste preventers, valves for closets, thicknesses and sizes of lead pipes, &c. To-wit, some water companies will insist upon your fixing a waste preventer cistern, such as is shown at Figs. 599, 645, 652, 653, &c., to each closet, whilst others will be satisfied with a waste preventing valve fixed in the cistern, as shown at Figs. 611, 612, 626, 628, 640, 644, &c.; others will allow you to fix a waste preventing valve, such as is shown at Figs. 561, 560, 562, and 563, underneath the seat, and other companies will allow you to do nearly as you please, providing you give a proper supply without undue waste. Then again, in the country, where there are no water companies, you may fix an ordinary round, shoe, or spring valve with the usual service box arrangement, as shown at Fig. 597, or at Figs. 592, 565, or 566; or the closet may be supplied with water as you please. If the cistern is some distance away from the closet, it may be arranged by using a regulator closet having the valve attached, as shown at Figs. 485, 486, or as shown at Figs. 545, 550, 553, 560, &c. These are the points which should be left to the judgment of the *qualified* plumber; at least, if it is not so, the architect should communicate with the water company of that particular district, seeking information as follows: Do you require waste preventing valves fixed in your district of ———? and if so, state what valves you do require or prefer to have used; also state what size and substance pipes are necessary (here state the particulars of building). The same also applies to the Vestry or other authorities having to do with the drainage, and it will always be found prudent to communicate with these bodies for instruction before the specification is drawn, or provide sufficient margin to cover up such contingencies. As a rule, these authorities will send you printed forms or particulars, which will save trouble and annoyance when the work has to be passed.

DRAINAGE SPECIFICATION.

First ascertain whether it is necessary to obtain a license, or to lodge plans of drains with Vestry or other authority, and if so, obtain and deliver same in due form. Pay all necessary fees for connecting drain with sewer or for repairing pavement, road work, &c.

Excavator.

Dig all required trenches to proper depths and properly shore up the sides, as shown on page 160 or 161, P. J. Davies' "Standard Practical Plumbing." If necessary, make artificial bottom for drain pipes to rest upon, and as shown and described on pages 160 and 161 in the before named work. After the pipes are laid and passed, fill in ground and let the earth be well rammed down, and make good roads, paths, paving, &c., and cart away all superfluous earth, &c., and leave all clean and tidy.

Specification of Drain Pipes and Fittings.

All the drain pipes and fittings to be of the best salt glazed earthenware, even, smooth, and free from flaws or other imperfections, and all junctions to be of the Y kind, or of easy angles, and proper and suitable bends and other fittings to be used throughout the work.

Pipe Layer.

Lay in and upon a solid foundation, with proper falls as delineated on page 156, under the heading, Fall of Drains, P. J. Davies' "Practical Plumbing," a (here state the size of pipe) 6in. best salt glazed even and smooth drain pipe, free from flaws or other imperfections, from sewer to the point marked on plan for the intercepter trap, such (here upon the plan of the drain the place for the intercepter should be shown, as at TRAP, Figs. 356 and 357, also see Figs. 394 and 395) pipes to be laid with proper cement, joints properly faced on the outside, and wiped clean and flush on the inside part, so as to be smooth and clean or otherwise free from rough surfaces; the whole of the open pipe ends to have wood stoppers, so as to keep them closed during the time the work is proceeding.

Main or Intercepter Traps (Selection of).

These traps are very numerous and require your particular attention in selection. Fig. 380 is the best, being in one piece; Fig. 386 being simply the same trap with a lip at the inlet. Fig. 385 is a similar trap, but with the inlet rounded and nearly level with the outlet. Fig. 387 is the same kind of trap, having a clearing eye A on its side. Fig. 388 is a trap similar in action to Fig. 380, but much shorter from inlet to outlet. Fig 389 is the old-fashioned siphon trap, which has been largely used for these last thirty years, but is not so good a form of trap as Fig. 380, because in Fig. 380 there is a drop for the water from W to Y, and the higher this drop is the better, as the water falling down this cathetus knocks or stirs up any sedimentary matter which may lie in the bottom of the trap, see B D, Fig. 381, also K, Fig. 384, also A D, Fig. 390. Fig. 382 shows the trap Fig. 387 fixed in the manhole with channel branches at E G F R A, for inspection and clearing purposes; but these channels, if not properly constructed, are a most filthy and abominable unmitigated nuisance, for the water coming down these channels, when not properly manipulated, splashes over the upper surfaces of the man-hole about G Q and R; in fact, I may here mention that such was the case with this particular manhole which was built as a model for sanitary work at the sanitary houses, South Kensington Health Exhibition, 1884; so that if the model is not properly constructed it would only be natural for one to expect to see such evils at other times, and for my part I am totally at a loss to understand why such toys have been introduced, as there cannot be anything better than that shown in Figs. 396, 394, 390 and 384, 383 and 381. In fact, I unhesitatingly

say, that taking all the surrounding circumstances into consideration, that Fig 382, or the channel intercepter trap, is only a farce, and not the work which may be expected to be designed by a practical workman.

Main Trap or Intercepter.

Provide and fix at the point marked on plan a main trap or intercepter, as shown at Fig. 390, and delineated on page 169 of P. J. Davies' "Standard Practical Plumbing" (here, if the trap is to be fixed in a man-hole as at Fig. 381 or 396, specify accordingly.

Drain Pipe Ventilation.

Provide and fix a 4in. air or ventilating pipe as shown at SEWER VENT PIPE, Fig. 396 of the above work, and bring it to within 12 inches of the surface of the ground, and to such place as may be hereafter directed for the plumber to connect his ventilating pipe to.

Drain Fresh Air Inlet Pipe.

Provide and fix to where directed on plan or otherwise a 4in. pipe for conveying fresh air to the main trap as shown at 2, and 34, Figs. 394 and 396 in the above work.

Specification of Main Drain (*Continued*).

As from the intercepter trap 2, Figs. 394 and 396, P. J. Davies' "Standard Practical Plumbing," continue the main drain with 6in. pipes with all necessary bends and branches, up to the soil pipes, and with 4in. pipes with proper junctions to all gully traps, and provide at the end of each length of drain pipe a cleansing eye with iron or stoneware stoppers, as shown at CLEARING HOLE on the plan 394 in the before-mentioned work, and continue the pipes for the purpose of ventilation to the different points shown on the drawing, or which may be hereafter pointed out.

Drain pipes passing through walls must be fixed at least three inches away from the upper brickwork, and in such a way that the pipes cannot be broken (should a settlement take place), and as shown at A B, Fig. 397, Davies' "Practical Plumbing."

Testing Drains.

All the drains must be filled and stand charged with water without leakage for at least five hours, which must be done by stopping up the outlets and filling from the highest point, as delineated on page 172 in the above-mentioned work. A good plan, which I have for some years past used to stop up the drain, is shown at Fig. 769, and which will be readily understood from the following: R is a rubber ring about 1in. in thickness and 5¾in. over; B is a wood block, the one end of which is made to fit the ring, the other end 5¾in. diameter; P is an iron plate 5¾in. over; through the plate P passes a 12in. bolt, with leather washer on the head; N is a horned nut which on being turned up brings the plate up with pressure, and causes it to spread laterally and so fit the pipe, making a good joint. In the year 1879 I invented a very powerful smoke slow-burning kind of squib; but in the year 1883 I nearly smothered the inmates of No. 4, Grosvenor Gardens, with one, after which I would not use it again. It has lately been called the smoke rocket, and, as usual, fresh claimants are being found for its originality. [For machine for testing drain pipes and joints, see Testing Machine and also Testing Pipes, &c., next volume.]

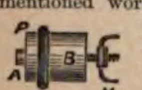


Fig. 769.

Inspection by the Architect or his Representative.

Every facility and aid must be afforded to the architect or his representative for inspection during the progress and on completion of the work. *No drain pipes or fittings to be covered before being approved of by the architect.*

Inspection Chamber.

If inspection chambers are built, the size should be at the bottom part at least 5ft. by 2ft. 6in., brought tapering up to the surface to suit cover, as shown at Fig. 391, which should be, if fixed in areas of an air tight character. *See* page 169.

Alteration of Drawings.

TAKE NOTICE. Should there be any deviation from the course marked upon the drain plan, such deviation must be carefully noted in the specification, and marked upon the plans lodged with the vestry or other authorities, and also on the plans in the architect's office, &c.

Storm Water.

TAKE NOTICE. In some districts the storm or rain water will not be allowed to enter the sewer; in such cases a separate drain must be provided.

Storm Water and Cesspools.

It will not always answer to allow the storm or rain water to enter cesspools, as when such is the case the cesspool will become too quickly filled, unless the cesspool water can easily soak away. These are little contingencies which the architect must be on the look-out for; for, if not, however good the planning may be, the working may be a failure.

N.B. It must be distinctly understood that all drains to cesspools must be properly trapped, and the pipes ventilated as you would were you dealing with the main drain and sewer.

Cesspool Overflows.

In some districts you will be allowed to connect an overflow to the cesspool. When such is the case, see that this overflow pipe is fixed at least three inches below the inlet pipe, so that the water in the the cesspool cannot back up the main drain.

Cesspool Floats.

Sometimes it will be desirable to fix a tell-tale or float which will show or give an audible signal, such as to ring an electric or other bell. Such an apparatus I exhibited in the Sanitary Exhibition, held at Kensington in the year 1881, which was also fitted for detecting blocked-up drains.

Cesspools.

The size of the cesspool must be determined by the size of the house, or number of closets discharging thereinto, or by the judgment of the architect or builder. The ordinary size for a house with seven or eight rooms, and in such districts where the liquid will soak away, is from six to eight feet in diameter, and 10 or 12 feet in depth; but should the bottom and sides of the cesspool be built with impervious material, *and no overflow allowed*, then the cesspool should be two or three times the size. Some of the cesspools about the village of Hornsey, and where the ground is of a very impervious nature, are built as follows: A house having from two to six rooms has the cesspool 6ft. in diameter; a seven-roomed house, 7ft. in diameter, and so on, increasing 6in. extra diameter for every additional room up to ten rooms, and then increasing 3in. in diameter for every additional room up to twenty rooms; and after this increasing 1½in. in diameter for every additional room; the general depth of these cesspools being from ten to fifteen feet, brick lined, and domed over. As a rule, the Hornsey cesspools are provided with an overflow, with a filtering media for the liquid to percolate through. Cesspools must be well ventilated with inlet and outlet air pipes; and the drain properly trapped in the usual manner.

Cesspools and Wells.

Where wells are in the vicinity, the walls, bottom, and overflow of the cesspool should be of a decided impervious character, to prevent the sewerage percolating into the springs of the well. VERY IMPORTANT.

Gully or Sink Traps (Hints upon).

These are requisites which should receive great care in selection; they should not be selected too large or too small for the work, 4in. being the general size used, and should be as easy cleansing as possible. For ordinary rain water pipes, Figs. 415, 416, may be employed, the size of which is generally 4in. For area or yard gully traps, Figs. 418, 419, 420, or 421 may be employed. I myself rarely use anything different to Fig. 418, or Fig. 419, or 420. For butler's pantry and other sinks not having grease thrown down them, these traps are found to answer very well; they also answer for bath wastes, and such like, as the pipes can be brought under the gratings, through the sockets marked by dotted lines and otherwise.

These traps should be fixed with discretion, and be never fixed in places where they will be likely to become dry, for if so, the whole system of drainage may by this very cause be put out of order, so far as regards its ventilation, as one of the secrets of ventilation is the adaptation of proper openings as fresh air inlets with suitable outlets.

Scullery Sink Wastes and Traps.

For scullery sinks where not much grease will be likely to be thrown down Fig. 395 works very well, but it is quite as well to fix this trap as far as possible from the sink, and convey the water through a trapped lead pipe, in order that the water can get partially chilled before entering the trap; in fact, I have run the leaden pipe through a cistern of water, in order that it may be cool before entering the gully trap. The lead pipe should enter the trap as shown at A, and the water from the sink should fall into this gully trap with some considerable force, which tends to keep this trap clean. At other times, the scullery sink trap may be as shown at Fig. 421, which catches the fat instead of allowing it to enter the drain; at other times, and where much fat is likely to be thrown down the sink, it will be necessary to fix a fat-trap, as shown at Fig. 423, or Fig. 424, and which requires to be cleansed out periodically. N.B. The sink grating *must* be made according to the rules laid down on page 133 in order that the waste pipe can be thoroughly scoured out by the action of the water, otherwise this pipe will become clogged with fat.

Specification for Gully Traps.

Provide and fix 4in. gully traps with iron grids, as shown at Fig. 418, or 419, or 420, Davies' "Standard Practical Plumbing." The top of which to be fixed, so that the pavement can be sloped down, so that the water may properly drain into the trap. Coach-house table gully traps, or places where carriages are washed, should have the gully trap constructed as shown at YARD GULLY, Fig. 396, and have a wrought-iron grid about 12in. square, for the water to drain away; or instead of the above named grid, Fig. 759 may be used.

Specification for 4in. Lead Soil and Ventilating Pipes.

Provide and fix a 4in. lead soil pipe (here name the place) to receive the closets, &c., on —— floors, with all necessary branches, bends, set-offs, wall-hooks, tacks, or ears, and continue the same, full size, from the drain pipes, and make good with Portland cement, as shown at A B, Fig. 453, Davies' "Standard Practical Plumbing," and carry the same to the highest point of roof to act as an efficient ventilator to the soil pipe, and, if necessary, the drains, the outlet to be at least 15ft. away from any opening or window. The above soil and ventilating pipe, together with all branches, to have *wiped soldered* joints throughout, and to be wrought and fixed on the most approved principle, and in the best workmanlike manner. Cover the open end of the soil air pipe with a dome-shaped lead strainer.

Specification for 4in. Iron Soil Pipes.

Provide and fix a 4in. cast iron circular soil pipe at least ⅜in. in thickness, with strong sockets of sufficient thickness to stand sound caulking with spun yarn and molten lead, similar to street water mains, as shown at X F Y, Fig. 453, P. J. Davies' "Standard Practical Plumbing," and to be properly caulked up with the caulking tools and hammer. Provide all necessary bends, springs, and set-offs, and fix the whole of the pipes with sufficiently strong supports, stays, lugs, ears, brackets or other fixings, and fixed so that the pipe part will stand 1½in. away from the walls to allow for painting.

All branches leading from the closets, &c., into this 4in. iron pipe to be of 8lb. lead pipes, with proper wiped joints, sockets, astragals, &c., the sockets and astragals to be made to match the sockets and astragals of the cast iron pipe, and to be caulked with spun yarn, and where lead to iron is fixed to be run with brimstone, resin or mutton suet, or otherwise made good with unions or other suitable connections, as shown at G H, or K L M N, or S R Q, Fig. 453, Davies' "Standard Practical Plumbing," and have all sound and water-tight. All lead to lead joints to be *wiped* in a workmanlike manner with plumbers' solder.

The iron soil pipe to be carried full bore from the drain to the highest point of the roof, the outlet of which must be made to act efficiently as a ventilator to the whole of the soil pipes, and if necessary, the drains, and to be fixed at least 15ft. away from any opening window, or other opening, and to be covered with a lead dome-shaped strainer. Make good the soil pipe to drain with Portland cement.

Specification of Traps for Closets, &c.

All branches leading from the soil pipe to closets, sinks, urinals, or otherwise, to be properly trapped with properly constructed, easy-cleansing momentaless and also siphon proof, 7lb. lead traps, suitable in size and otherwise for the different work connected with these branches, and so as to effectually prevent stinks passing from the soil pipe nto the house.

Sewer Vent Pipe.

TAKE NOTICE (*of separate ventilation pipes*).

In some districts the authorities insist upon your fixing a separate ventilating pipe for the ventilation of the sewer and drain, upon the sewer side of the intercepter trap, as shown at SEWER VENT PIPE, Fig. 384, and VENTILATING PIPE, Fig. 390, also at SEWER VENT PIPE, Fig. 396. When such is the case it is best to stipulate as follows:—

Specification of Sewer Ventilating Pipe.

Provide and fix, with all necessary bends, set-offs, tacks, ears, or other appropriate fastenings, a 4in. (here name lead or iron, which you prefer, as stipulated in soil and ventilating pipes' specification, but if iron pipe see that there be no sharp bends to catch the iron rust) pipe from sewer side of intercepter trap, and carry the same above the highest point of the building, and at least 20ft. away from any opening window, or other opening, especially

chimneys. The joints of the above pipes to be made as directed in the soil and ventilating pipes before mentioned; cover this vent pipe with a dome-shaped lead strainer.

Fresh Air Inlet Pipes to Drains.

Some engineers are very careless in the matter of the fresh air inlet pipes to drains; they simply bring the drain pipe up, as shown at AIR SHAFT, Fig. 390, and leave it flush with the ground, often making it to answer the purpose of a sink; when such is the case the holes are liable to become choked, and the whole thing is useless; therefore it is necessary to work against such contingencies, and provide a metal pipe with perforations, as shown at 34, Fig. 396, and carried some distance above the ground, which prevents leaves and the like getting into this ventilating pipe. Other engineers are found to carry this fresh air inlet pipe to the top of the house, as shown at B C E, Fig. 343. This latter plan is desirable in places where this fresh air inlet pipe is apt to become an outlet, for a further account of which, see page 150.

Waste Pipes (Hints on).

In places where practicable all the waste pipes should be brought to discharge into one lot of stack pipe, and heads to receive the same from the different floors, as shown at L G Q, Fig. 474; N, Fig. 472, L, Fig. 354, &c.
Such stack pipes should be always made to discharge into a gully trap, as shown at A, Fig. 354, and at GULLY TRAP, Fig. 472, but not upon or over the grid, as it is apt to splash about and make the place dirty.

Specification for Waste Pipes.

Provide and fix (here name the places) a 2in. lead waste pipe with wall-hooks and all necessary tacks or ears, with 7lb. lead heads at suitable places to receive the waste pipes, from (here state wherever it is for) bath, wash-basin, sink, &c., as shown at Figs. 473, 474, and 472, and 354, P. J. Davies' "Standard Practical Plumbing."

N.B.—If urinals or housemaids' slop-sinks are to be fixed, specify that the latter shall have a non-siphonable trap, and the wastes must be branched into the soil pipe, or to be taken down independently of the other waste pipes, for when urine is thrown down these sinks it causes them to stink equal to a soil pipe; in fact, the housemaid's sink pipe and also urinal waste pipes should be treated the same as you would a soil pipe (see SINK 16, 14, 36, 35, Fig. 339), and never allowed to empty into the same pipes as the lavatory basins, bath wastes, drip sinks, overflows and such like.

Specification of Fresh Air Inlet Pipes.

Provide and fix where directed a 4in. fresh air inlet pipe, with bossed over top and sufficient ½in. perforated holes, as shown at 34, Fig. 396, Davies' "Practical Plumbing," and properly fix this pipe with ears, and make good with Portland cement to drain pipe.
N.B.—With this fresh air inlet pipe it may be found necessary to carry it to the top of the roof, and when such is the case keep it at least 10ft. lower than the exhaust or outlet pipe.

Cisterns (Hints on).

Cisterns for closet work, especially in districts where the water does not act upon the materials, will be best made of lead. They should be made in size (if supplied by the usual town water companies) sufficiently large to hold two days' water supply for whatever they are intended to supply. The reason for making them to this size is to allow for the time when the company's mains or other part of the works are out of order, and especially in the winter season. See Cisterns.

Specification for Cisterns.

Provide and fix (here name your wood) lead cistern at ———— with 6lb. lead sides and 7lb. lead bottom, with properly wiped soldered angles. (Here, if the solder is likely to be acted upon by the water, specify with burnt joints, as shown at Fig. 75.)
Provide and fix with properly soldered joint a 1¼in. overflow pipe to the above cisterns, and carry same to discharge into the open air, or where may be directed.
Provide and fix a washer and plug with waste pipe dished down and properly soldered into the bottom of the cistern, for cleaning out purposes, and carry the waste pipe to discharge over the nearest appropriate place.
Provide and lay on from company's main, with suitable ferrule and stopcock, a communication or main pipe (here name the size pipe; if the water is on constantly, a ½-in. or if for a long length of pipe, say 150 feet, then a ¾in. pipe under a fair pressure will supply almost any size tank suitable for closet work) of suitable substance, according to the water company's rules and regulations, with screw boss, copper ball, and of equal size to main pipe, *Underhay's* pattern, best make equilibrium ball valve, properly fixed with wall hooks, and wiped joints throughout.
In other words, this main pipe may be described as follows, which will answer for all the water companies about London, and to fill almost any cistern under constant supply, and it is good enough for any water company in England:
Provide and fix a ¾in. No. 45 lead pipe, with ferrule, to suit the water company, with ¾ screw down Rotherham pattern stout brass stop-cock, with ¾ Underhay's best screw boss copper ball equilibrium ball valve.
Should you have any doubt as to the brass work, you can specify that all the brass work shall bear the stamp of the New River Company, which will then be a guarantee for its quality, they stamping it after testing at their works.
With regard to the draw-off and other pipes about the premises, they must be put in with stopcocks, and sizes according to discretion.
There is a table on page 36 which will give the weights for the different heads of water, but the sizes must be left to your judgment, which the following may perhaps assist: For draw-offs to all sinks with a head of water from 7 to 30ft., a ¾in. pipe and ¾in. cock will suffice for ordinary work. But for heads of water below 7ft., an inch pipe and inch cock should be used. For heads of water above 30ft., a ½in. pipe and ½in. cock will answer. All brass work should be screw boss cocks, or valves with wiped soldered joints.
N.B.—The above lengths of pipes should be enlarged one size should the amount of horizontal or inclined pipe exceed that of the vertical of the lowest given figures. For sizes of lead pipe, see Table of Lengths, etc., page 36.

Bath Supplies.

It is usual to supply the cold water to baths with 1in. pipes and 1in. cocks, but when there is a strong head, say over 25ft., a ¾in. pipe may be employed. A full-way stop-cock should be fixed upon this pipe (see N.B. above).

Wash Basins.

These are usually supplied with ½in. lead pipes, but for low pressure perhaps ¾in. would be more desirable.

Waste Pipes.

All sinks should have at least 1½in. lead waste pipes with lead traps below sinks, and with proper sized gratings as laid down on page 133.

Housemaids' Sinks.

Housemaids' sinks, as shown at 16, Fig. 339, should have the waste pipe and trap as there shown, the top of which should be covered with 6lb. lead.

Butlers' Pantry Sinks

Should be lined with 7lb. lead with 8lb. bottoms, similar to an ordinary lead cistern, which see. See that the washer and plug is large enough: use a 2½in. See next volume.

Lavatory Basin Wastes

Should be 1in. pipes and properly trapped; the overflow pipes should be taken away separately, and not branched into the waste pipe (as if branched in it spoils the draft of the waste pipe, and also causes it to make a gurgling noise when emptying).

Bath Wastes

Should be not larger than the outlet valve, so that the pipe may be properly filled to cause a draft. 1in. lead pipe with 10 or 12ft. fall will answer for bath wastes, but if the fall be less a 1¼in. lead pipe should be used. The overflow pipe must be taken down independently; other pipes must not be branched into the bath waste.

Baths and lavatory basins will be fully treated of in the next volume; also water supply.

Specification of Closet Safes.

Provide and fix a 5lb. sheet lead safe, 4ft. long, 1ft. 9in. wide, and 6in. deep, or if the opening is less to such sizes as will suit the closet, with properly bossed or wiped up angles, and solder the same to the inlet of trap or soil pipe.

Provide and fix a 2½in. overflow pipe, properly dished and soldered to the safe, as shown at D R, Fig. 481, P. J. Davies' "Standard Practical Plumbing," the outlet of the overflow pipe to be carried to the most suitable position, and made to discharge into the open air, or over a rain water head, but not to be fixed in any way where it can possibly become a nuisance by the wind blowing the water on the walls, etc.

Provide and fix upon the outlet end of this overflow pipe a copper flap, as shown in the above work, at Fig. 483, properly but lightly hinged, so as when not in use to be closed, in order to exclude wind.

Specification of Closets (Hints upon.)

This is a point which will require your particular attention, inasmuch as one closet apparatus is useful and good for one place, whilst another apparatus for the same place would be totally useless. As a general rule, it is admitted on all sides, and I also say, that the valve closet for private use in a gentleman's house is the best apparatus which can be employed; but in this apparatus, like all others in the plumbing trade, there is a great variety of makers, and it is to this point which I now claim your particular attention, for it is not of the slightest use for you to specify a best valve closet unless you see that you get it. For this purpose you had better specify that the closets selected shall bear upon the dish of the handle the maker's name and address, of whom you may think proper to specify. This is of the greatest importance, for there are but very few who can be trusted with the manufacture of these particular articles; in fact, they are like watches: good valve closets will keep in order, whilst the duffers will assuredly be a continual nuisance.

Judging Valve Closets.

On page 200 I have said sufficient for a workman to judge how to select a good closet. I may also further add that a good valve closet can be detected by watching at intervals to see if the bottom valve is sound, but see that the inlet supply is thoroughly shut off (which may be told by placing the side of your forefinger against the back of the basin where the water enters; if the inlet valve leaks it will dribble over the finger, and thus plainly show itself.) A good valve closet should hold its water, work exceedingly smooth, and without the slightest noise. The water should flush every part of the pan, as shown at Fig. 547, and stand the test referred to under the heading of "Proving Closet Flushing," pages 226 and 227, and not spurt upwards, nor in any way damp the seat. I should call your particular attention to the plan for testing the flushing, as shown on page 226, under the heading of "Proving Closet Flushing."

Specification for Valve Closets suitable for Working with Waste Preventer Cisterns.

Provide and fix over lead safe (here name the quantity of closets, also their positions, and name of maker) best valve closet, as shown at Fig. 628, and also Fig. 611, P. J. Davies' "Standard Practical Plumbing," cost price, each £5 5s., with lead box outlet, sunk dish (bearing maker's name and address), glass cut amber handle, blue flush rim (or other fancy basin, such as white and gold, or figured) basin, with all brass work properly finished and lacquered, with suitable cranks, and with at least ⅛in. copper wire.

Specification of Waste Preventer Cisterns suitable for Valve Closets.

Provide to each valve closet and fix upon brackets (or as otherwise may be directed), with 1¼in. down, discharge, or closet supply pipe, with wiped joint to union, an after-flush noiseless waste-preventing cistern, with necessary cranks, and ⅛in. copper wires, as shown at Fig. 652, or at Fig. 616, P. J. Davies' "Standard Practical Plumbing," and in such a manner that the closet basin shall be thoroughly flushed each time it is put into action. Lay on the water from the large cistern (or main if allowed, but the cistern preferred) with ¾in. stout lead pipe, with wiped soldered joints.

Provide and fix a 1¼in. overflow pipe from the waste preventing cistern, and make same to discharge at the most convenient place, but so as not to be to any parties objectionable, nor in such a position that the wind may blow into this waste preventing cistern, to cause the water to become frozen during the winter season.

Specification of valve closets suitable for ordinary service box work (or for such places where waste preventers, such as Figs. 618 or 638, P. J. Davies' "Standard Practical Plumbing," are allowed to be fixed in cisterns), as shown at Figs. 565, 566, 597, 598, 626, or 628 in the above named work, or suitable for round valves, shoe or spring valve work. (Here repeat specification for valve closets suitable for working with waste preventing cisterns.)

Specification of Valves suitable for supplying Valve Closets from Service Boxes.

Provide and fix suitable waste preventing or other valves and full sized 7lb. lead service box (as shown at Fig. 578, Davies' "Practical Plumbing"), in cistern above closet, with all necessary cranks, wires, ball levers, and with suitable sized pipes according to the scale delineated on page 227 in the above work, under the heading of Proving Closet Flushing.

Specification of Valve Closet (and Hints).

Sometimes these closets are provided with waste preventing valve attached, such as is shown at Fig. 561, and also attached to the closet at Fig. 560, and also as shown at Figs. 562 and 563, the last of which is an after-flush valve, which insures an after-flush to fill the basin should the handle be held too long, a very important point in connection with valve closets, inasmuch as it always insures a proper supply to the basin, save and except shortness of water.

Provide and fix over lead safe a best valve closet, with lead box or outlet, sunk dish, bearing maker's name and address, together with glass cut amber handle, blue flush rim (or other fancy or figured) basin, with all brass work properly finished and lacquered, with waste preventer valve attached, capable of discharging sufficient water to thoroughly flush the basin and closet at each operation, cost price, £6 6*s.* 0*d.*

Provide and lay on water from cistern to valve closet (here name the nearest cistern suitable), with suitable sized pipes according to scale, as specified on page 227, Davies' "Practical Plumbing," under the heading of Proving Closet Flushing, and in such a manner that the closet basin shall be thoroughly flushed each time it is put into action.

Specification of Regulator Valve Closets where Waste Preventers are not required, and for places where the Cistern is a long distance from the Closet.

Provide and fix over lead safe a best regulator valve closet (here name the maker), as shown at Figs. 266 and 485, Davies' "Standard Practical Plumbing," with lead box outlet and *suitable size valve* and *copper* bellows regulator, with sunk dish, bearing maker's name and address, and with amber glass cut handle, and blue flush rim (or here state other fancy) basin, all the brass work to be properly finished and lacquered.

Lay on the water with suitable sized lead pipe of proper substance and sizes according to scale, and as specified on page 227, P. J. Davies' "Practical Plumbing," under the heading of Proving Closet Flushing, and with wiped soldered joints throughout, and in such a manner that the closet basin shall be *thoroughly* flushed at each operation.

This is all that is necessary for valve closet work.

Pan Closets.

Some architects are still in favour of fixing pan closets, but I cannot say that I approve of their ideas, for I consider this closet a very unsanitary piece of mechanism, and totally unfit for its intended purpose, inasmuch as in a short time the internal parts become besmeared with soil, and consequently become offensive; however, it is only my duty to point out the different inventions and modes of working and fixing, and if I give hints upon such inventions, they must be taken in good faith, as I do not wish to in any way influence my reader beyond the simple pointing out, according to my views, that which I consider good or bad (for improvements in pan closets see BANNER'S Patent, Fig. 353).

Specification for Pan Closet.

Provide and fix over lead safe a best pan closet with sunk dish (bearing maker's name) cut glass amber pull, with blue flush rim basin, and lay on the water (if there is a water company, say according to the rules and regulations of the water company) and with suitable valves and pipes, according to the scale as laid down on pages 226 and 227, P. J. Davies' "Standard Practical Plumbing," and in such a manner that the basin shall be thoroughly flushed at each pull of the handle.

N.B.—These pan closets may be supplied with water as specified in the valve closet work, or as shown with waste preventer and service box arrangements at Figs. 611, 626, and 632; or it may be supplied from a small cistern as shown at Fig. 613; or better, with the after-flush cistern, as shown at Figs. 616 or 652; or, in fact, there are many other cisterns which will answer, and which are shown in different parts of the work.

Sometimes it will be more convenient to fix a waste preventer valve, as shown at Fig. 561 or 563, to these pan closets, and to work below the closet seat; but you must first find out whether the water company will pass them or not.

At other times, when waste preventers are not required, the supply valve may be fixed as shown at Fig 490, and, in fact, in many other ways.

Common closets for such places as where slops may occasionally thrown down, also suitable for servants' W.C.'s, or for cottage property and such like. I may here remark that I am thoroughly in favour of these closets, if *properly* flushed, and which is of the utmost importance.

Common Closets for Fixing Upstairs without Waste Preventers.

Provide and fix a balloon flush rim basin (here specify any other basin you may be in favour of) with valve and sunk dish, and slotted pull (to allow the handle to drop flush and suddenly) with copper bellows regulator, also provide and lay on the water with *Stout* lead pipes, to supply the closet basin, such valve and pipes to be of ample strength and size, and according to the scale laid down in P. J. Davies' "Standard Practical Plumbing," page 227, and in such a manner that the closet basin shall be thoroughly flushed at each pull of the closet handle.

N.B.—When the closet is fixed upon the ground floor, so that the drains can come up to the closet, or say, in the basement, then the closet may have an earthenware trap, and may be specified, as shown at Figs. 545, 525, 413, 549, 550, 551, 552, &c.

Should you require to specify any particular water waste preventer, it will be as well to first ascertain what class the water company will pass. As a rule, Tylor's, Lambert's, Bolding's, Warner's, Hayward Tyler's, Winn's, Triton's, Fell & Co., Guest & Chrimes' are allowed.

Waste Preventer to Common Closets.

If it is necessary for you to state the class of waste preventer, it will be well for you to say, provide and fix a cast iron waste preventer cistern of approved form, and to be approved of by the water company. Such cisterns are shown fitted up at Figs. 599, 613, 640, 643, 645, 653, 668, 671, &c.; but if the water Company will allow you to fix a simple waste preventing valve in the large cistern it will often be much the best and save expense; then ascertain what class may be used. There are many shown fitted up and otherwise in the pages of this work, and which are to be seen at Figs 596, 600, 604, 605, which is a very good plan, 611, 618, 625, 626, 629, 631, 637, 638, 639, 640, 644, 667, 670.

Stable Gully Traps (Hints upon).

In this case, the gully trap should be one easy to clean out, with iron grid, which may be fastened in such a manner that it cannot be removed by the horses' hoofs. (See Stable Drainage.) I have on many occasions fixed the ordinary traps, such as is shown at Figs. 414 and 415, and fixed upon the top the ordinary cast iron gully grids, as shown at Fig. 395.

For Roof Work, Pumps, Wells, and Town and other Water Supply, Bath, Hot Water and Gas Work Specifications, see next Volume.

EXAMINATION QUESTIONS.

Lead Burning.

Joint Making.

PAGE

Describe and give a section to show how a drain pipe should be jointed ... 164
How should drain pipes be laid in the earth and covered up? ... 164
How would you test for the soundness of a drain when first laid? ... 172
What is the best kind of drain pipe jointing materials? 164
Describe the effects of walls on drains when built direct upon the pipes ... 172
Describe how you would test a drain and soil pipes, together with the general fittings of an occupied house ... 173
What is the smoke test? ... 173
What is the peppermint test and how is it applied? ... 173
How would you test for a main trap? ... 173
Describe and make a drawing of how you would form all junctions or branches for drainage purposes ... 174
What class of hopper basins would you prefer to fix for an ordinary servants' W.C. ... 175
Describe and give drawings of some yard gullies .. 176
Describe a scullery sink waste pipe, grating and trap
Describe and give drawing of a fat trap ... 177
How would you force a common W.C.? ... 178
Describe what is a secret tack for a rain water pipe... 179
Describe the method of fixing tacks on soil pipe. *Say how many* you would put on a 10ft. length of pipe, also the size, and what substance material you would use for upright work ... 181
Give drawings of ornamental tacks ... 182
What are astragals? How are they fixed? ... ...
What is an astragal joint? ... 185
Describe how you would make good a 4in. lead soil pipe to a 6in. drain pipe or bend ... 188
Describe how you would connect a lead soil pipe to an iron pipe ... 188
What distance would you keep the centre of the dip of a trap from the back brick-work to suit a valve closet? Size of closet 6ft. square ... 190, 191
Would you fix the centre of the trap for a valve closet central in a 4ft. closet? ... 190
What distance would you fix the dip of a trap from the back wall for a pan closet? ... 191
Describe and illustrate the method of marking out for a trap and soil pipe to show the cutting lines, the outgo, and also for the bend or branch into the vertical soil pipe. The lines must be for ᑌ-traps, also for half ᔓ-traps ... 192, 193
What class of trap would you fix in a place where ventilation could not be obtained to prevent the bad effect of siphonic action? ... 194
By diagrams and description show disconnection of a bath waste and overflows; also waste of a lavatory waste and overflow discharging into or above a head; show how the head down pipe should discharge itself ... 195, 196
How would you ventilate a closet trap (of any class)? 118
Show two methods ... 119, 197
Show how the water in a cistern may become contaminated with foul air by the bad arrangements of waste pipes ... 198
What is a dog-eared safe? ... 199
What width would you make a lead safe for a valve closet, and what size overflow pipe would you fix to the same (size of closet 6ft. by 5ft. wide)? ... 199

Closets.

What is the best means of distributing the water over the surface of closet basins? ... 175
What is a Sharp's pattern basin? ... 175

PAGE

What is a valve closet? Give a sketch of this class of closet ... 120, 200
How would you test a valve closet? ... 200
What is a regulator valve closet? ... 201
What is a self-closing valve closet? ... 201
Describe one of Jennings' closets ... 201
Describe a pan closet, and give a sectional sketch of same ... 202
Name a few of the principal points to keep in view when fixing water closets ... 226, 227
What size pipe and valve would you use to supply a closet, the cistern being 5ft. above the closet? ... 227
What size pipe and valve would you use to supply a closet, the cistern being 8ft. above the closet? Also state size of pipes and valves for supplying closets having the cisterns the following heights above the floor of the closets, viz: 7ft., 12ft., 20ft., 30ft., 40ft., 60ft., 70ft., 80ft., 90ft.? ... 227
State what you would do if the above lengths of pipes were increased in length by taking the above lengths of pipes horizontally, namely, the actual lengths of piping to be doubled in each case ...
What class of closet would you use for a public house closet such as is generally visited by the rougher class of tap-room people ... 204
Describe a latrine, and give a sketch ... 204
Describe a public urinal, and give a sketch 204, 207, 208, 209
What is a cradle urinal? ... 206
What is a lipped urinal? ...
Describe three modes of flushing urinals
One with waste preventer cistern ...
One with waste preventer cock or valve ... 206
One worked with treadle arrangement ... 207
What is the general height for fixing a urinal? ... 208
Describe a lavatory and swing urinal combined ... 208
What are the salts deposited in urinals from the urine? 208
How would you dissolve the salts or fur deposited on the sides of a urinal? ... 208, 228
What are the main points to keep in view when selecting stop-cocks for closet work? ... 210
Describe a full way ground-in plug stop cock ... 210
Describe a ground-in plug round way stop cock ... 210
Describe a plug square way stop cock ... 211
Describe a double shut down screw down stop cock ... 211
Describe an ordinary screw down Rotherham pattern stop cock with stuffing box and loose valve ... 211
What are the advantages of the ordinary screw down cock over the ordinary ground-in pattern plug cock for fixing under high pressure? ...
What are the advantages of the ordinary ground-in stop cock over the ordinary screw down cock for low pressure work? ... 211
What is a diaphragm pattern screw down stop cock? 211
Describe a full way screw down stop cock and its advantages under high pressure work in sanitary plumbing ... 212
What is a self closing stop cock? ... 212
What is a stool cock? ... 212
What is a stool valve? ... 213
What is a regulator closet valve? ... 214
Describe some closet valves having water regulators to regulate the descent of the valve to give after flush ... 214, 215
What is a bellows regulator for closets? ... 216
What is an oil regulator for closets? ... 216
Describe a diaphragm closet valve and state what point should be guarded against when selecting these valves ... 217
Describe a few of the causes for closet valves leaking 218
How would you prove or test the water supply to a closet basin? ... 227

PAGE

Write out a few specifications for the drainage of a farm, a mansion, a villa, cottage, and stable, to include excavator, pipe layer, main trap, drain and soil pipe ventilation (for town drainage, also for cess-pool work), sinks, gully traps, lead soil pipes, traps, closets, cisterns, wastes, baths, wash basins, laundry supplies of water, butler's pantry sinks, waste preventers, and, in fact, specify the whole of the sanitary work suitable for the before-mentioned places. Say the mansion to have 100 rooms; farm for 30 cows, 50 pigs, 20 horses; and a 30-roomed house, having pump water and closets on ground and also on first floor, each building to have its own specification ... ... 322 to 327

What will kill the scent of oil of peppermint? ...

On page 173 you are told how to test a drain with chemicals, &c., and as oil of peppermint is likely to become the article of use, it may be well for you to know what will counteract the scent of the same; chloride of lime will answer your purpose, which may be mixed with water, and thrown down the pipe or otherwise.

(For laundry work see next Vol.)

Lead Light Glazing.

Give a sketch and description of the method of starting a square lead light, showing one side and end calme set; also two rows of squares or with leads ... 293

What is a ladkin or ladakin? 293

What is a setting knife? 294

How is window lead made? 31

Give a cross section of a piece of window lead about full size 294

What is a glass cutting gauge? Give drawing ... 295

How are bands or ties put on?

Suppose your light to be 2in. short and narrow for the opening, how would you get over the difficulty? ... 297

How would you cement a lead light? 296

Suppose your lead light to be made too large for the opening, how would you get over the difficulty? ... 297

What rules are there to be observed in the working of the lead work in lead light glazing so as to make a good finish? 298

Which are the three fundamental colours used in stained glass? 298

What is pot metal glass? 299

What is flashed glass? 299

Can cathedral, or the rough kind of glass be made to any shade? 299

What peculiarity is there about Aventurine glass? ... 299

Strike out a true lozenge according to P. J. Davies' system 300

PAGE

Do you know anything of Geometry? If so, strike out two or three geometrical patterns for exhibiting lead light glazing in shop windows 300

Firstly, strike out a pattern showing a square within a lozenge 299

Secondly, strike out a pattern showing a square and circle design, which is done by striking a circle about a square; next strike a square about a circle. For fixing the leads divide the inner square by drawing lines from corner to corner, and divide the sides in halves. The glass for the circle to be in four pieces 300

Strike out a design with one equilateral triangle within a circle, also with an equilateral triangle without a circle, which is done by first striking the circle, then strike an inscribed equilateral triangle within the circle. From the points of the inscribed triangle as centres, and with the radius of the sides, strike arcs cutting each other, from which draw right lines cutting the points of the triangle, which will form a triangle about the given circle, and complete the figure 301

Strike a design for a lead light window, the size of which is 1ft. 9in. by 1ft. 6in. Nothing but triangular panes are to be used in this light 300

Strike out a design for a lead light window 1ft. 3in. by 1ft. 3in., the panes on the inside work to be of the diamond pattern, but not necessarily true, the external panes to be triangles 301

Strike out a lead-light window having hexagonal panes for the inner part of the work 301

Make up the external parts of the light Fig. 700, with suitable parts of the hexagonal panes ... 302

Make a drawing of a geometrical design for lead-light, showing every joint and lead; the design to be composed of right lines and curves with a circle in the centre. The panes to be of regular shape 302

Set out a quarry light circular top window, size 4ft. 4in. by 1ft. 10in., without a border (which may be added). I require 8 panes from the apex of the arch to the bottom of window, and 6 panes wide; what will be the size of the panes, after allowing for the leads? 304

Set out a church window having diamond panes with ornamental top... 305

Give a few examples of fretwork and borders ... 305

Show a lead light screen 306

Show a lead light window blind 306

Show a window glazed with trapezoidal-shaped panes 307

Show some small corner pieces 307

Show a few examples of ornamental fretwork lead-light glazing 309

Show a geometrical and ornamental fretwork window, one with round tops and one with square top with borders 310

(ABOUT HALF-SIZE.)

PLAN FOR FOREMAN'S TIME SHEET.

WEEKLY ACCOUNT OF MEN'S TIME AND MATERIALS.

Where at ? *General W. H. Smith, Wimbledon Park.*

For Week ending *September* 23*rd*, 1883.

P. J. DAVIES' WORKMEN'S TIME SHEET.

Foreman, *Charles Jones.* (*The address should be written here.*)

NAMES.	S.	M.	T.	W.	T.	F.	Tot'l	at	AMOUNT.			HOW EMPLOYED.
								d.	£	s.	d.	
John Finch, *Bricklayer.*	4	9	9	7	9	7	45	9	1	13	9	*Building Garden Wall (see his time sheet).*
William Smith, *Bricklayer.* *Pay back time (Smith).*	4½	9	9	9	9	9	49½	9	1	17	1	*Pointing round back of house and Building Chimney (see his time sheet)*
Walter Jones, *Plasterer.*	3	5	9	9	8	9	43	9	1	12	3	*Putting up centre flowers in Drawing Room & Hall (see time sheet).*
Dick Dean, *Carpenter.*	5	9	9	9	9	9	50	9	1	17	6	*Taking up floors and cutting away for Plumbers.*
Henry Wilson, *Carpenter.*	5	9	9	9	9	9	50	9	1	17	6	*Putting first floor Joist on Stable.*
Walter Johnson, *Carpenter.*	4	8	7½	9	9	9	46½	9	1	14	10½	*Making New Stall in end of Stable.*
Henry Dickson, *Carpenter.* *Put two more Carpenters on for Monday.*	5	9	9	9	9	9	50	9	1	17	6	*Fixing Doors and Sashes.*
William Walters, *Blacksmith.* *This work is costing too much (Sack Walters when job is done).*	6	10	10	10	10	10	56	10	2	6	8	*Fixing Iron Palisading, also Balusters on Best Staircase.*
P. Wilson, *Plumber.*	4	8	8	8	8	8	44	10	1	16	8	*Fixing Soil-pipes and Traps to Back Staircase Closets.*
R. Bolton. *Plumber.*	4½	9	8	9	8½	8½	47½	10	1	19	7	*Lead laying on Roof.*
T. Jordan, *Plumber.* *Pay Jordan back day.*	4½	9	9	9	8½	9	49	10	2	0	10	*Lining Sinks and Cisterns.*
Bricklayers' Labourers, *J. Brian.*	4	9	9	9	9	9	49	6½	1	6	6½	*Attending on Bricklayers and Stacking Bricks.*
J. Smith.	5	9	8	8	8	9	47	6½	1	5	5½	*Making up Mortar and supplying Bricklayers.*
Plasterers' Labourers, *W. J. Jones.*	5	9	9	9	9	9	50	6½	1	7	1	*Attending on Plasterer.*
Dick Dale.	5	9	9	9	9	9	50	6½	1	7	1	*Making Putty and Coarse Stuff.*
Plumbers' Labourers, *Charles Turke,*	4½	9	9	8	8½	9	49	7	1	8	7	*Attending on R. Bolton, Plumber.*
George Johns,	4½	9	8	9	8½	8½	47½	7	1	7	8½	*Attending on Jones, Plumber.*
Dickings.	4	8	8	8	8	8	44	7	1	5	8	*Attending on Wilson, Plumber.*
Carpenters' Labourers, *J. Parks.*	5	10	10	10	10	10	55	6	1	7	6	*Assisting with Stable Joist, &c.*
W. Mead. *Pay Mead back day.*	5	10	10	10	10	10	55	6	1	7	6	
								£	32	6	10	N.B.—This Time Sheet must not be torn. Put the Materials on the other side.

[ABOUT HALF-SIZE.]

PLAN FOR A TIME SHEET,

To be given up on Friday Evening or first thing Saturday Morning.

Write plainly in Ink as stated here and below; do not tear or soil this Time Sheet, which must be made up and kept ready for inspection first thing each morning. No money or wages under any pretence will be paid unless these and the rules below are strictly complied with

Write Name and Trade on this line, *Thomas Jordan, Plumber.*

Write your Address on this line, 31, *Old Lane, Hammersmith.*

P. J. DAVIES' Workman's Time Sheet for the Week ending *September* 23, 1883.

	WHERE AT.	Minutely write down the description of Work done each Day, and within the spaces for each day, and the time taken on EACH Job in the Hours' column.	HOURS.
Saturday's work	*General W. H. Smith, Wimbledon-pk.*	*To measuring Lead for large Tank in Turret; also the Cistern on third floor; also the Cistern on ground floor; also for the two Butler's Pantry Sinks; also for the two Housemaid's Sinks; and also for the Washing-up Sink in Scullery.*	4½
Monday's work	*Ditto.*	*To making Plank Platform for unrolling the sheet Lead for Cisterns.*	3
		To cutting out and taking up into the turret the Lead for lining large Tank.	4
		To unrolling, flapping out Lead, and turning up the two sides for large Tank.	2
Tuesday's work.	*Ditto.*	*To putting Lead into large Tank in Turret, soiling and preparing same for soldering.*	2½
		To shaving Lead and soldering up large Tank, 97 ft. run of soldering.	6½
Wednesday's work	*Ditto.*	*To cutting out Lead for Cistern on third floor and getting same up to Cistern.*	4
		To flapping out Lead and lining Cistern on third floor, and soldering up same, 30 ft. of soldering.	5
Thursday's work	*Ditto.*	*To cutting out Lead for Cistern on ground floor and taking same to Cistern.*	4
		To cutting out Lead for Butler's Pantry Sinks, and taking same to Sinks.	2
		To cutting out Lead for Housemaid's Sinks and taking same to Plumber's Shop.	3
Friday's work.	*Ditto.*	*To lining two Butler's Pantry Sinks, 24 ft. of soldering.*	5
		To lining two Housemaid's Sinks.	4
On the other side write the Materials either taken out or received, together with date when received or returned, and where for or from. If scaffolding, steps, ladders, cords, ropes, trucks, carting, &c., be had or used, state for how long employed, when taken out or returned.		Total Hours	49½

INDEX.

☞ All numbers refer to the paging except where it is distinctly printed "figure." Many of the titles in this index will be found under the ordinary headings, but many entries are also made in this index which have been taken from the middle or other portions of the paragraphs to save a multiplicity of headings; such will be notified by a star thus * before the page figures, and when the index refers to illustrations *only*, there will be two stars before the page figures thus **.

* See middle &c., of Paragraphs (see Deads, *18). ** See Illustrations only (see Urinals, self-acting, **209). † This signifies Act of Parliament

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* See middle, &c., of Paragraphs (see Deads, 18). ** See Illustrations only (see Urinals, self-acting, **209). † Signifies Act of Parliament.

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* See middle of Paragraphs (see Deads, *18). ** See Illustrations only (see Urinals, self-acting, **209). † Signifies Act of Parliament.

LEAD LIGHT AND STAINED GLASS GLAZING.

* See middle, &c., of Paragraph (see Deads, *18). ** See Illustrations only (see Urinals, self-acting, **209). † Signifies Act of Parliament.